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Best Demonstrated Available Technology (BDAT) Background Document for K101 and K102: Low Arsenic Subcategory

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FINAL

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT FOR

K101 AND K102

LOW ARSENIC SUBCATEGORY

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In promulgating treatment standards for K101 and K102 nonwastewaters, the Agency established two subcategories: Low Arsenic and High Arsenic Subcategories. The Low Arsenic Subcategory is defined as those K101 and K102 wastes that contain less than 1% total arsenic. The High Arsenic Subcategory is defined as those K101 and K102 wastes that contain greater than or equal to 1% total arsenic.
This background document provides the Agency's rationale and technical support for selecting the constituents to be regulatee iun the K101 and K102 wastes and for developing treatment standards for those regulated constituents. The document also provides waste characterization information that serves as the basis for determining whether variances may

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EXECUTIVE SUMMARY

BDAT Treatment Standards for K101 and K102

Pursuant to section 3004(m) of the Hazardous and Solid Waste Amendments (HSWA) enacted on November 8, 1984, the Environmental Protection Agency (EPA) is establishing best demonstrated available technology (BDAT) treatment standards for the listed wastes identified in 40 CFR 261.32 as K101 and K102. Compliance with these BDAT treatment standards is a prerequisite for placement of the wastes in units designated as land disposal facilities according to 40 CFR Part 268. The effective date of these treatment standards is August 8, 1988.

In promulgating treatment standards for K101 and K102 nonwastewaters, the Agency has established two subcategories: the Low Arsenic Subcategory and the High Arsenic Subcategory. The Low Arsenic Subcategory is defined as those K101 and K102 wastes that contain less than 1 percent total arsenic. The High Arsenic Subcategory is defined as those K101 and K102 wastes that contain greater than or equal to 1 percent total arsenic. In this background document, the promulgated treatment standards apply only to the Low Arsenic Subcategory. Treatment standards for nonwastewaters in the High Arsenic Subcategory will be established by the Agency at a later date. Until these treatment standards are established, K101 and K102 nonwastewaters in the High Arsenic Subcategory are restricted from land disposal according to the "soft hammer" provisions, as stated in the Preamble for this rule, Section III (c) 3.

This background document provides the Agency's rationale and technical support for selecting the constituents to be regulated in the K101 and K102 wastes and for developing treatment standards for those regulated constituents. The document also provides waste characterization information that serves as the basis for determining whether variances may be warranted for a particular waste that has the same waste code but has waste characteristics that make it more difficult to treat than the waste upon which the BDAT treatment standards are based.

The introductory section, which appears verbatim in all the First Third background documents, summarizes the Agency's legal authority and promulgated methodology for establishing treatment standards, and discusses the petition process necessary for requesting a variance from these treatment standards. The remainder of the document presents waste-specific information -- the number and locations of facilities affected by the land disposal restrictions for the K101 and K102 wastes, the waste generating process, characterization data, the technologies used to treat the waste (or similar wastes), and available performance data, including data on which the treatment standards are based. The document also explains EPA's determination of BDAT, selection of constituents to be regulated, and calculation of treatment standards.

According to 40 CFR 261.32, waste codes K101 and K102, which are generated by the veterinary pharmaceutical industry, are listed as follows:

K101: Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo- arsenic compounds.

K102: Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.

EPA has estimated that two facilities in the veterinary pharmaceutical industry are potential generators of the K101 and K102 wastes. Generators of K101 and K102 wastes generally fall under Standard Industrial Classification (SIC) Code 2834 (veterinary pharmaceutical).

Treatment standards are established for both nonwastewater and wastewater forms of K101 and K102. (For the purpose of determining the applicability of the treatment standards, wastewaters are defined as wastes containing less than 1 percent (weight basis) total suspended solids* and less than 1 percent (weight basis) total organic carbon (TOC). Waste not meeting this definition must comply with the treatment standards for nonwastewaters.

For K101/K102 wastewaters, the Agency is establishing treatment standards for arsenic, cadmium, lead, and mercury. Additionally, treatment standards are also established for ortho-nitroaniline* in K101 and ortho-nitrophenol in K102. Wastewater forms of K101 and K102 represent the scrubber water from the incineration of K101 and K102. The scrubber waters are classified as K101/K102 wastewaters as a result of the "derived-from" rule and the "mixture" rule as outlined in 40 CFR 261.3 (definition of hazardous waste). The treatment standards are based on performance data from chemical precipitation. Performance data were transferred from D004 wastes for arsenic, cadmium, lead, and mercury in K101 and K102 and for ortho-nitroaniline in K101 and ortho-nitrophenol in K102. The Agencyis deferring a treatment standard for antimony until a later date.

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* The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, total suspended solids is measured by method 209c (Total Suspended Solids Dried at 103 to 105°C) in Standard Methods for the Examination of Water and Wastewater, 16th edition.

For K101/K102 nonwastewaters, the Agency is establishing treatment standards for cadmium, chromium (total), lead, and nickel. Additionally, treatment standards are also established for ortho-nitroaniline in K101 and ortho-nitrophenol in K102. Treatment standards are based on performance data from rotary kiln incineration followed by stabilization of the ash residue. These treatment standards apply to the "derived-from" forms of nonwastewater K101/K102, which are the ash residue from incineration and the precipitate from chemical precipitation of the wastewater. Performance data were transferred from F006 wastes for cadmium, chromium (total), lead, and nickel. Treatment standards for antimony, arsenic, and barium were deferred for a later date.

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* This constituent is not on the list of constituents in the Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT"), EPA/530-SW-87-011, March 1987. It is a ground-water monitoring constituent as listed in Appendix IX, 40 CFR Part 264, 51 FR 26639, July 24, 1986.

The following table presents the treatment standards for K101 and K102 wastes, Low Arsenic Subcategory. The treatment standards for wastewaters are total composition and reflect the concentration of constituents in the waste and the units are mg/l (parts per million on a weight-by-volume basis). The treatment standards for nonwastewater metals reflect the concentration of constituents in the leachate from the Toxicity Characteristic Leaching Procedure (TCLP) and the units are mg/l (parts per million on a weight-by-volume basis). The treatment standards for nonwastewater organics are expressed as total composition and the units are mg/kg (parts per million on a weight-by-weight basis). If the concentrations of the regulated constituents in K101 and K102 wastes, as generated, are lower than or equal to the proposed BDAT treatment standards, then treatment is not necessary as a prerequisite to land disposal.

BDAT Treatment Standards for K101 Low Arsenic Subcategory (Less Than 1 Percent Total Arsenic)

	Maximum for any single grab sample		
	Nonwastewater		Wastewater
Constituent	Total concentration (mg/kg)	TCLP leachate concentration (mg/l)	Total concentration (mg/l)
Semivolatile Organics			
Ortho-nitroaniline	14	NA	0.27
Metals			
Arsenic	NA	NA	2.0
Cadmium	NA	0.066	0.24
Chromium	NA	5.2	NA
Lead	NA	0.51	0.11
Mercury	NA	NA	0.027
Nickel	NA	0.32	NA

BDAT Treatment Standards for K102 Low Arsenic Subcategory (Less Than 1 Percent Total Arsenic)

Constituent	Maximum for any single grab sample		
	Nonwastewater		Wastewater
	Total concentration (mg/kg)	TCLP leachate concentration (mg/l)	Total concentration (mg/l)
Semivolatile Organics			
Ortho-nitrophenol	13	NA	0.028
Metals			
Arsenic	NA	NA	2.0
Cadmium	NA	0.066	0.24
Chromium	NA	5.2	NA
Lead	NA	0.51	0.11
Mercury	NA	NA	0.027
Nickel	NA	0.32	NA

1. INTRODUCTION

This section of the background document presents a summary of the legal authority pursuant to which the best demonstrated available technology (BDAT) treatment standards were developed, a summary of EPA's promulgated methodology for developing the BDAT treatment standards, and, finally, a discussion of the petition process that should be followed to request a variance from the BDAT treatment standards.

1.1 Legal Background

1.1.1 Requirements Under HSWA

The Hazardous and Solid Waste Amendments of 1984 (HSWA), which were enacted on November 8, 1984, and which amended the Resource Conservation and Recovery Act of 1976 (RCRA), impose substantial new responsibilities on those who handle hazardous waste. In particular, the amendments require the Agency to promulgate regulations that restrict the land disposal of untreated hazardous wastes. In its enactment of HSWA, Congress stated explicitly that "reliance on land disposal should be minimized or eliminated, and land disposal, particularly landfill and surface impoundment, should be the least favored method for managing hazardous wastes" (RCRA section 1002(b)(7), 42 U.S.C. 6901(b)(7)).

One part of the amendments specifies dates on which particular groups of untreated hazardous wastes will be prohibited from land disposal unless "it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" (RCRA section 3004(d)(1), (e)(1), (g)(5), 42 U.S.C. 6924 (d)(1), (e)(1), (g)(5)).

For the purpose of the restrictions, HSWA defines land disposal "to include, but not be limited to, any placement of . . . hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave" (RCRA section 3004(k), 42 U.S.C. 6924(k)). Although HSWA defines land disposal to include injection wells, such disposal of solvents, dioxins, and certain other wastes, known as the California List wastes, is covered on a separate schedule (RCRA section 3004(f)(2), 42 U.S.C. 6924 (f)(2)). This schedule requires that EPA develop land disposal restrictions for deep well injection by August 8, 1988.

The amendments also require the Agency to set "levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized" (RCRA section 3004(m)(1), 42 U.S.C. 6924 (m)(1)). Wastes that satisfy such levels or methods of treatment established by EPA, i.e., treatment standards, are not prohibited from being land disposed.

In setting treatment standards for listed or characteristic wastes, EPA may establish different standards for particular wastes within a single waste code with differing treatability characteristics. One such characteristic is the physical form of the waste. This frequently leads to different standards for wastewaters and nonwastewaters. Alternatively, EPA can establish a treatment standard that is applicable to more than one waste code when, in EPA's judgment, a particular constituent present in the wastes can be treated to the same concentration in all the wastes.

In those instances where a generator can demonstrate that the standard promulgated for the generator's waste cannot be achieved, the amendments allow the Agency to grant a variance from a treatment standard by revising the treatment standard for that particular waste through rulemaking procedures. (A further discussion of treatment variances is provided in Section 1.3.)

The land disposal restrictions are effective when promulgated unless the Administrator grants a national variance and establishes a different date (not to exceed 2 years beyond the statutory deadline) based on "the earliest date on which adequate alternative treatment, recovery, or disposal capacity which protects human health and the environment will be available" (RCRA section 3004(h)(2), 42 U.S.C. 6924 (h)(2)).

If EPA fails to set treatment standards by the statutory deadline for any hazardous waste in the First Third or Second Third waste groups (see Section [illegible].2), the waste may not be disposed in a landfill or surface impoundment unless the facility is in compliance with the minimum technological requirements specified in section 3004(o) of RCRA. In addition, prior to disposal, the generator must certify to the Administrator that the availability of treatment capacity has been investigated, and it has been determined that disposal in a landfill or surface impoundment is the only practical alternative to treatment currently available to the generator. This restriction on the use of landfills and surface impoundments applies until EPA sets treatment standards for the waste or until May 8, 1990, whichever is sooner. If the Agency fails to set treatment standards for any ranked hazardous waste by May 8, 1990, the waste is automatically prohibited from land disposal unless the waste is placed in a land disposal unit that is the subject of a successful "no migration" demonstration (RCRA section 3004(g), 42 U.S.C. 6924(g)). "No migration" demonstrations are based on case-specific petitions that show there will be no migration of hazardous constituents from the unit for as long as the waste remains hazardous.

1.1.2 Schedule for Developing Restrictions

Under section 3004(g) of RCRA, EPA was required to establish a schedule for developing treatment standards for all wastes that the Agency had listed as hazardous by November 8, 1984. Section 3004(g) required that this schedule consider the intrinsic hazards and volumes associated with each of these wastes. The statute required EPA to set treatment standards according to the following schedule:

1. Solvent and dioxin wastes by November 8, 1986;
2. The "California List" wastes by July 8, 1987;
3. At least one-third of all listed hazardous wastes by August 8, 1988 (First Third);

4. At least two-thirds of all listed hazardous wastes by June 8, 1989 (Second Third); and

5. All remaining listed hazardous wastes and all hazardous wastes identified as of November 8, 1984, by one or more of the characteristics defined in 40 CFR Part 261 by May 8, 1990 (Third Third).

The statute specifically identified the solvent wastes as those covered under waste codes F001, F002, F003, F004, and F005; it identified the dioxin-containing hazardous wastes as those covered under waste codes F020, F021, F022, and F023.

Wastes collectively known as the California List wastes, defined under section 3004(d) of HSWA, are liquid hazardous wastes containing metals, free cyanides, PCBs, corrosives (i.e., a pH less than or equal to 2.0), and any liquid or nonliquid hazardous waste containing halogenated organic compounds (HOCs) above 0.1 percent by weight. Rules for the California List were proposed on December 11, 1986, and final rules for PCBs, corrosives, and HOC-containing wastes were established August 12, 1987. In that rule, EPA elected not to establish treatment standards for metals. Therefore, the statutory limits became effective.

On May 28, 1986, EPA published a final rule (51 FR 19300) that delineated the specific waste codes that would be addressed by the First Third, Second Third, and Third Third land disposal restriction rules. This schedule is incorporated into 40 CFR 268.10, 268.11, and 268.12.

1.2 Summary of Promulgated BDAT Methodology

In a November 7, 1986, rulemaking, EPA promulgated a technology-based approach to establishing treatment standards under section 3004(m).

Congress indicated in the legislative history accompanying the HSWA that "[t]he requisite levels of [sic] methods of treatment established by the Agency should be the best that has been demonstrated to be achievable," noting that the intent is "to require utilization of available technology" and not a "process which contemplates technology-forcing standards" (Vol. 130 Cong. Rec. S9178 (daily ed., July 25, 1984)). EPA has interpreted this legislative history as suggesting that Congress considered the requirement under section 3004(m) to be met by application of the best demonstrated and achievable (i.e., available) technology prior to land disposal of wastes or treatment residuals. Accordingly, EPA's treatment standards are generally based on the performance of the best demonstrated available technology (BDAT) identified for treatment of the hazardous constituents. This approach involves the identification of potential treatment systems, the determination of whether they are demonstrated and available, and the collection of treatment data from well-designed and well-operated systems.

The treatment standards, according to the statute, can represent levels or methods of treatment, if any, that substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents. Wherever possible, the Agency prefers to establish BDAT treatment standards as "levels" of treatment (i.e., performance standards), rather than to require the use of specific treatment "methods." EPA believes that concentration-based treatment levels offer the regulated community greater flexibility to develop and implement compliance strategies, as well as an incentive to develop innovative technologies.

1.2.1 Waste Treatability Groups

In developing the treatment standards, EPA first characterizes the waste(s). As necessary, EPA may establish treatability groups for wastes having similar physical and chemical properties. That is, if EPA believes that hazardous constituents in wastes represented by different waste codes could be treated to similar concentrations using identical technologies, the Agency combines the wastes into one treatability group. EPA generally considers wastes to be similar when they are both generated from the same industry and from similar processing stages. In addition, EPA may combine two or more separate wastes into the same treatability group when data are available showing that the waste characteristics affecting performance are similar or that one of the wastes in the group, the waste from which treatment standards are to be developed, is expected to be most difficult to treat.

Once the treatability groups have been established, EPA collects and analyzes data on identified technologies used to treat the wastes in each treatability group. The technologies evaluated must be demonstrated on the waste or a similar waste and must be available for use.

1.2.2 Demonstrated and Available Treatment Technologies

Consistent with legislative history, EPA considers demonstrated technologies to be those that are currently used on a full-scale basis to treat the waste of interest or a waste judged to be similar (see 51 FR 40588, November 7, 1986). EPA also will consider as demonstrated treatment those technologies used to separate or otherwise process chemicals and other materials on a full-scale basis. Some of these technologies clearly are applicable to waste treatment, since the wastes are similar to raw materials processed in industrial applications.

For most of the waste treatability groups for which EPA will promulgate treatment standards, EPA will identify demonstrated technologies either through review of literature related to current waste treatment practices or on the basis of information provided by specific facilities currently treating the waste or similar wastes.

In cases where the Agency does not identify any facilities treating wastes represented by a particular waste treatability group, EPA may transfer a finding of demonstrated treatment. To do this, EPA will compare the parameters affecting treatment selection for the waste treatability group of interest to other wastes for which demonstrated technologies already have been determined. (The parameters affecting treatment selection and their use for this waste are described in Section 3.2 of this document.) If the parameters affecting treatment selection are similar, then the Agency will consider the treatment technology also to be demonstrated for the waste of interest. For example, EPA considers rotary kiln incineration to be a demonstrated technology for many waste codes containing hazardous organic constituents, high total organic content, and high filterable solids content, regardless of whether any facility is currently treating these wastes. The basis for this determination is data found in literature and data generated by EPA confirming the use of rotary kiln incineration on wastes having the above characteristics.

If no full-scale treatment or recovery operations are identified for a waste or wastes with similar physical or chemical characteristics that affect treatment selection, the Agency will be unable to identify any demonstrated treatment technologies for the waste, and, accordingly, the waste will be prohibited from land disposal (unless handled in accordance with the exemption and variance provisions of the rule). The Agency is, however, committed to establishing treatment standards as soon as new or improved treatment processes are demonstrated (and available).

Operations only available at research facilities, pilot- and bench-scale operations, will not be considered in identifying demonstrated treatment technologies for a waste. Nevertheless, EPA may use data generated at research facilities in assessing the performance of demonstrated technologies.

As discussed earlier, Congress intended that technologies used to establish treatment standards under section 3004(m) be not only "demonstrated," but also "available." To decide whether demonstrated technologies may be considered "available," the Agency determines whether they (1) are commercially available and (2) substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste. These criteria are discussed below.

1. Commercially available treatment. If the demonstrated treatment technology is a proprietary or patented process that is not generally available, EPA will not consider the technology in its determination of the treatment standards. EPA will consider proprietary or patented processes available if it determines that the treatment method can be purchased or licensed from the proprietor or is a commercially available treatment. The services of the commercial facility offering this technology often can be purchased even if the technology itself cannot be purchased.

2. Substantial treatment. To be considered "available," a demonstrated treatment technology must "substantially diminish the toxicity" of the waste or "substantially reduce the likelihood of migration of hazardous constituents" from the waste in accordance with section 3004(m). By requiring that substantial treatment be achieved in order to set a treatment standard, the statute ensures that all wastes are adequately treated before being placed in or on the land and ensures that the Agency does not require a treatment method that provides little or no environmental benefit. Treatment will always be deemed substantial if it results in nondetectable levels of the hazardous constituents of concern (provided the nondetectable levels are low relative to the concentrations in the untreated waste). If nondetectable levels are not achieved, then a determination of substantial treatment will be made on a case-by-case basis. This approach is necessary because of the difficulty of establishing a meaningful guideline that can be applied broadly to the many wastes and technologies to be considered. EPA will consider the following factors in an effort to evaluate whether a technology provides substantial treatment on a case-by-case basis:

   - Number and types of constituents treated;

   - Performance (concentration of the constituents in the treatment residuals); and

   - Percent of constituents removed.

EPA will only set treatment standards based on a technology that meets both availability criteria. Thus, the decision to classify a technology as "unavailable" will have a direct impact on the treatment standard. If the best demonstrated technology is unavailable, the treatment standards will be based on the next best demonstrated treatment technology determined to be available. To the extent that the resulting treatment standards are less stringent, greater concentrations of hazardous constituents in the treatment residuals could be placed in land disposal units.

There also may be circumstances in which EPA concludes that for a given waste none of the demonstrated treatment technologies are "available" for purposes of establishing the 3004(m) treatment performance standards. Subsequently, these wastes will be prohibited from continued placement in or on the land unless managed in accordance with applicable exemptions and variance provisions. The Agency is, however, committed to establishing new treatment standards as soon as new or improved treatment processes become available.

1.2.3 Collection of Performance Data

Performance data on the demonstrated available technologies are evaluated by the Agency to determine whether the data are representative of well-designed and well-operated treatment systems. Only data from well-designed and well-operated systems are considered in determining BDAT. The data evaluation includes data already collected directly by

EPA and/or data provided by industry. In those instances where additional data are needed to supplement existing information, EPA collects additional data through a sampling and analysis program. The principal elements of this data collection program are: (1) the identification of facilities for site visits, (2) the engineering site visit, (3) the sampling and analysis plan, (4) the sampling visit, and (5) the onsite engineering report.

(1) Identification of facilities for site visits. To identify facilities that generate and/or treat the waste of concern, EPA uses a number of information sources. These include Stanford Research Institute's Directory of Chemical Producers; EPA's Hazardous Waste Data Management System (HWDMS); the 1986 Treatment, Storage, Disposal Facility (TSDF) National Screening Survey; and EPA's Industry Studies Data Base. In addition, EPA contacts trade associations to inform them that the Agency is considering visits to facilities in their industry and to solicit their assistance in identifying facilities for EPA to consider in its treatment sampling program.

After identifying facilities that treat the waste, EPA uses this hierarchy to select sites for engineering visits: (1) generators treating single wastes on site; (2) generators treating multiple wastes together on site; (3) commercial treatment, storage, and disposal facilities (TSDFs); and (4) EPA in-house treatment. This hierarchy is based on two concepts: (1) to the extent possible, EPA should develop treatment standards from data produced by treatment facilities handling only a single waste, and (2) facilities that routinely treat a specific waste have had the best opportunity to optimize design parameters. Although excellent treatment can occur at many facilities that are not high in this hierarchy, EPA has adopted this approach to avoid, when possible, ambiguities related to the mixing of wastes before and during treatment.

When possible, the Agency will evaluate treatment technologies using full-scale treatment systems. If performance data from properly designed and operated full-scale systems treating a particular waste or a waste judged to be similar are not available, EPA may use data from research facility operations. Whenever research facility data are used, EPA will explain in the preamble and background document why such data were used and will request comments on the use of such data.

Although EPA's data bases provide information on treatment for individual wastes, the data bases rarely provide data that support the selection of one facility for sampling over another. In cases where several treatment sites appear to fall into the same level of the hierarchy, EPA selects sites for visits strictly on the basis of which facility could most expeditiously be visited and later sampled if justified by the engineering visit.

(2) Engineering site visit. Once a treatment facility has been selected, an engineering site visit is made to confirm that a candidate for sampling meets EPA's criteria for a well-designed facility and to

ensure that the necessary sampling points can be accessed to determine operating parameters and treatment effectiveness. During the visit, EPA also confirms that the facility appears to be well operated, although the actual operation of the treatment system during sampling is the basis for EPA's decisions regarding proper operation of the treatment unit. In general, the Agency considers a well-designed facility to be one that contains the unit operations necessary to treat the various hazardous constituents of the waste, as well as to control other nonhazardous materials in the waste that may affect treatment performance.

In addition to ensuring that a system is reasonably well designed, the engineering visit examines whether the facility has a way to measure the operating parameters that affect performance of the treatment system during the waste treatment period. For example, EPA may choose not to sample a treatment system that operates in a continuous mode, for which an important operating parameter cannot be continuously recorded. In such systems, instrumentation is important in determining whether the treatment system is operating at design values during the waste treatment period.

(3) Sampling and analysis plan. If after the engineering site visit the Agency decides to sample a particular plant, the Agency will then develop a site-specific sampling and analysis plan (SAP) according to the Generic Quality Assurance Project Plan for the Land Disposal Restrictions Program ("BDAT"), EPA/530-SW-87-011. In brief, the SAP discusses where the Agency plans to sample, how the samples will be taken, the frequency

of sampling, the constituents to be analyzed and the method of analysis, operational parameters to be obtained, and specific laboratory quality control checks on the analytical results.

The Agency will generally produce a draft of the site-specific SAP within 2 to 3 weeks of the engineering visit. The draft of the SAP is then sent to the plant for review and comment. With few exceptions, the draft SAP should be a confirmation of data collection activities discussed with the plant personnel during the engineering site visit. EPA encourages plant personnel to recommend any modifications to the SAP that they believe will improve the quality of the data.

It is important to note that sampling of a plant by EPA does not mean that the data will be used in the development of BDAT treatment standards. EPA's final decision on whether to use data from a sampled plant depends on the actual analysis of the waste being treated and on the operating conditions at the time of sampling. Although EPA would not plan to sample a facility that was not ostensibly well designed and well operated, there is no way to ensure that at the time of the sampling the facility will not experience operating problems. Additionally, EPA statistically compares its test data to suitable industry-provided data, where available, in its determination of what data to use in developing treatment standards. The methodology for comparing data is presented later in this section.

(Note: Facilities wishing to submit data for consideration in the development of BDAT standards should, to the extent possible, provide sampling information similar to that acquired by EPA. Such facilities should review the Generic Quality Assurance Project Plan for the Land Disposal Restrictions Program ("BDAT"), which delineates all of the quality control and quality assurance measures associated with sampling and analysis. Quality assurance and quality control procedures are summarized in Section 1.2.6 of this document.)

(4) Sampling visit. The purpose of the sampling visit is to collect samples that characterize the performance of the treatment system and to document the operating conditions that existed during the waste treatment period. At a minimum, the Agency attempts to collect sufficient samples of the untreated waste and solid and liquid treatment residuals so that variability in the treatment process can be accounted for in the development of the treatment standards. To the extent practicable, and within safety constraints, EPA or its contractors collect all samples and ensure that chain-of-custody procedures are conducted so that the integrity of the data is maintained.

In general, the samples collected during the sampling visit will have already been specified in the SAP. In some instances, however, EPA will not be able to collect all planned samples because of changes in the facility operation or plant upsets; EPA will explain any such deviations from the SAP in its follow-up onsite engineering report.

(5) Onsite engineering report. EPA summarizes all its data collection activities and associated analytical results for testing at a facility in a report referred to as the onsite engineering report (OER). This report characterizes the waste(s) treated, the treated residual concentrations, the design and operating data, and all analytical results including methods used and accuracy results. This report also describes any deviations from EPA's suggested analytical methods for hazardous wastes that appear in Test Methods for Evaluating Solid Waste, SW-846, Third Edition, November 1986.

After the OER is completed, the report is submitted to the waste generator and/or treater for review. This review provides a final opportunity for claiming any information contained in the report as confidential. Following the review and incorporation of comments, as appropriate, the report is made available to the public with the exception of any material claimed as confidential.

1.2.4 Hazardous Constituents Considered and Selected for Regulation

(1) Development of BDAT list. The list of hazardous constituents within the waste codes that are targeted for treatment is referred to by the Agency as the BDAT constituent list. This list, provided as Table 1-1, is derived from the constituents presented in 40 CFR Part 261, Appendices VII and VIII, as well as several ignitable constituents used as the basis of listing wastes as F003 and F005. These sources provide a

Table 1-1 BDAT Constituent List

BDAT reference no.	Constituent	CAS no.
	Volatile organics	
222.	Acetone	67-64-1
1.	Acetonitrile	75-05-8
2.	Acrolein	107-02-8
3.	Acrylonitrile	107-13-1
4.	Benzene	71-43-2
5.	Bromodichloromethane	75-27-4
6.	Bromomethane	74-83-9
223.	n-Butyl alcohol	71-36-3
7.	Carbon tetrachloride	56-23-5
8.	Carbon disulfide	75-15-0
9.	Chlorobenzene	108-90-7
10.	2-Chloro-1,3-butadiene	126-99-8
11.	Chlorodibromomethane	124-48-1
12.	Chloroethane	75-00-3
13.	2-Chloroethyl vinyl ether	110-75-8
14.	Chloroform	67-66-3
15.	Chloromethane	74-87-3
16.	3-Chloropropene	107-05-1
17.	1,2-Dibromo-3-chloropropane	96-12-8
18.	1,2-Dibromoethane	106-93-4
19.	Dibromomethane	74-95-3
20.	trans-1,4-Dichloro-2-butene	110-57-6
21.	Dichlorodifluoromethane	75-71-8
22.	1,1-Dichloroethane	75-34-3
23.	1,2-Dichloroethane	107-06-2
24.	1,1-Dichloroethylene	75-35-4
25.	trans-1,2-Dichloroethene	156-60-5
26.	1,2-Dichloropropane	78-87-5
27.	trans-1,3-Dichloropropene	10061-02-6
28.	cis-1,3-Dichloropropene	10061-01-5
29.	1,4-Dioxane	123-91-1
[illegible]	2-Ethoxyethanol	110-80-5
[illegible]	Ethyl acetate	141-78-6
226.	Ethyl benzene	100-41-4
30.	Ethyl cyanide	107-12-0
227.	Ethyl ether	60-29-7
31.	Ethyl methacrylate	97-63-2
214.	Ethylene oxide	75-21-8
32.	Iodomethane	74-88-4
33.	Isobutyl alcohol	78-83-1
228.	Methanol	67-56-1
34.	Methyl ethyl ketone	78-93-3

Table 1-1 (Continued)

BDAT reference no.	Constituent	CAS no.
	Volatile organics (continued)	
229.	Methyl isobutyl ketone	108-10-1
35.	Methyl methacrylate	80-62-6
37.	Methacrylonitrile	126-98-7
38.	Methylene chloride	75-09-2
230.	2-Nitropropane	79-46-9
39.	Pyridine	110 86 1
40.	1,1,1,2-Tetrachloroethane	630-20-6
41.	1,1,2,2-Tetrachloroethane	79-34-5
42.	Tetrachloroethene	127-18-4
43.	Toluene	108-88-3
44.	Tribromomethane	75-25-2
45.	1,1,1-Trichloroethane	71-55-6
46.	1,1,2-Trichloroethane	79-00-5
47.	Trichloroethene	79-01 6
48.	Trichloromonofluoromethane	75-69-4
49.	1,2,3-Trichloropropane	96-18-4
231.	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
50.	Vinyl chloride	75-01-4
215.	1,2-Xylene	97-47-6
216.	1,3-Xylene	108-38-3
217.	1,4 Xylene	106-44-5
	Semivolatile organics	
51.	Acenaphthalene	208-96-8
52.	Acenaphthene	83-32-9
53.	Acetophenone	96-86-2
54.	2-Acetylaminofluorene	53-96-3
55.	4-Aminobiphenyl	92-67-1
56.	Aniline	62-53-3
57.	Anthracene	120-12-7
58.	Aramite	140-57-8
59.	Benz(a)anthracene	56 55 3
218.	Benzal chloride	98-87-3
60.	Benzenethiol	108-98-5
61.	Deleted	
62.	Benzo(a)pyrene	50-32-8
63.	Benzo(b)fluoranthene	205-99-2
64.	Benzo(ghi)perylene	191-24-2
65.	Benzo(k)fluoranthene	207-08-9
66.	p-Benzoquinone	106-51-4

Table 1-1 (Continued)

BDAT reference no.	Constituent	CAS no.
	Semivolatile organics (continued)	
67.	Bis(2-chloroethoxy)methane	111-91-1
68.	Bis(2-chloroethyl)ether	111-44-4
69.	Bis(2-chloroisopropyl)ether	39638-32-9
70.	Bis(2-ethylhexyl)phthalate	117-81-7
71.	4 Bromophenyl phenyl ether	101-55-3
72.	Butyl benzyl phthalate	85-68-7
73.	2-sec-Butyl-4,6-dinitrophenol	88-85-7
74.	p-Chloroaniline	106-47-8
75.	Chlorobenzilate	510-15-6
76.	p-Chloro-m-cresol	59-50-7
77.	2-Chloronaphthalene	91-58-7
78.	2-Chlorophenol	95-57-8
79.	3-Chloropropionitrile	542-76-7
80.	Chrysene	218-01-9
81.	ortho-Cresol	95-48-7
82.	para-Cresol	106-44-5
232.	Cyclohexanone	108-94-1
83.	Dibenz(a,h)anthracene	53-70-3
84.	Dibenzo(a,e)pyrene	192-65-4
85.	Dibenzo(a,i)pyrene	189-55-9
86.	m-Dichlorobenzene	541-73-1
87.	o-Dichlorobenzene	95-50-1
88.	p-Dichlorobenzene	106-46-7
89.	3,3'-Dichlorobenzidine	91-94-1
90.	2,4-Dichlorophenol	120-83-2
91.	2,6-Dichlorophenol	87-65-0
92.	Diethyl phthalate	84-66-2
93.	3,3'-Dimethoxybenzidine	119-90-4
94.	p Dimethylaminoazobenzene	60-11-7
95.	3,3'-Dimethylbenzidine	119-93-7
96.	2,4-Dimethylphenol	105-67-9
97.	Dimethyl phthalate	131-11-3
98.	Di-n-butyl phthalate	84-74-2
99.	1,4-Dinitrobenzene	100-25-4
100.	4,6-Dinitro-o-cresol	534-52-1
101.	2,4-Dinitrophenol	51-28-5
102.	2,4-Dinitrotoluene	121-14-2
103.	2,6-Dinitrotoluene	606-20-2
104.	Di-n-octyl phthalate	117-84-0
105.	Di-n-propylnitrosamine	621-64-7
106.	Diphenylamine	122-39-4
219.	Diphenylnitrosamine	86-30-6

Table 1-1 (Continued)

BDAT reference no.	Constituent	CAS no.
	Semivolatile organics (continued)	
107.	1,2 Diphenylhydrazine	122-66-7
108.	Fluoranthene	206-44-0
109.	Fluorene	86-73-7
110.	Hexachlorobenzene	118-74-1
111.	Hexachlorobutadiene	87-68-3
112.	Hexachlorocyclopentadiene	77-47-4
113.	Hexachloroethane	67-72-1
114.	Hexachlorophene	70-30-4
115.	Hexachloropropene	1888-71-7
116.	Indeno(1,2,3-cd)pyrene	193-39-5
117.	Isosafrole	120-58-1
118.	Methapyrilene	91-80-5
119.	3-Methylcholanthrene	56-49-5
120.	4,4'-Methylenebis (2-chloroaniline)	101-14-4
36.	Methyl methanesulfonate	66-27-3
121.	Naphthalene	91-20-3
122.	1,4-Naphthoquinone	130-15-4
123.	1-Naphthylamine	134-32-7
124.	2-Naphthylamine	91-59-8
125.	p-Nitroaniline	100-01-6
126.	Nitrobenzene	98-95-3
127.	4-Nitrophenol	100-02-7
128.	N-Nitrosodi-n-butylamine	924-16-3
129.	N-Nitrosodiethylamine	55-18-5
130.	N-Nitrosodimethylamine	62-75-9
131.	N-Nitrosomethylethylamine	10595-95-6
132.	N-Nitrosomorpholine	59-89-2
133.	N-Nitrosopiperidine	100-75-4
134.	N-Nitrosopyrrolidine	930-55-2
135.	5-Nitro-o-toluidine	99-65-8
136.	Pentachlorobenzene	608-93-5
137.	Pentachloroethane	76-01-7
138.	Pentachloronitrobenzene	82-68-8
139.	Pentachlorophenol	87-86-5
140.	Phenacetin	62-44-2
141.	Phenanthrene	85-01-8
142.	Phenol	108-95-2
220.	Phthalic anhydride	85-44-9
143.	2-Picoline	109-06-8
144.	Pronamide	23950-58-5
145.	Pyrene	129-00-0
146.	Resorcinol	108-46-3

Table 1 1 (Continued)

BDAT reference no.	Constituent	CAS no.
	Semivolatile organics (continued)	
147.	Safrole	94-59-7
148.	1,2,4,5-Tetrachlorobenzene	95-94-3
149.	2,3,4,6-Tetrachlorophenol	58-90-2
150.	1,2,4-Trichlorobenzene	120-82-1
151.	2,4,5-Trichlorophenol	95-95-4
152.	2,4,6-Trichlorophenol	88-06-2
153.	Tris(2,3-dibromopropyl) phosphate	126-72-7
	Metals	
154.	Antimony	7440-36-0
155.	Arsenic	7440-38-2
156.	Barium	7440-39-3
157.	Beryllium	7440-41-7
158.	Cadmium	7440-43-9
159.	Chromium (total)	7440-47-3
221.	Chromium (hexavalent)	-
160.	Copper	7440-50-8
161.	Lead	7439-92-1
162.	Mercury	7439-97-6
163.	Nickel	7440-02-0
164.	Selenium	7782-49-2
165.	Silver	7440-22-4
166.	Thallium	7440-28-0
167.	Vanadium	7440-62-2
168.	Zinc	7440-66-6
	Inorganics other than metals	
169.	Cyanide	57-12-5
170.	Fluoride	16964-48-8
171.	Sulfide	8496-25-8
	Organochlorine pesticides	
172.	Aldrin	309-00-2
173.	alpha-BHC	319-84-6
174.	beta-BHC	319-85-7
175.	delta-BHC	319-86-8

Table 1-1 (Continued)

BDAT reference no.	Constituent	CAS no.
	Organochlorine pesticides (continued)	
176.	gamma-BHC	58-89-9
177.	Chlordane	57-74-9
178.	DDD	72-54-8
179.	DDE	72-55-9
180.	DDT	50-29-3
181.	Dieldrin	60-57-1
182.	Endosulfan I	939-98-8
183.	Endosulfan II	33213-6-5
184.	Endrin	72-20-8
185.	Endrin aldehyde	7421-93-4
186.	Heptachlor	76-44-8
187.	Heptachlor epoxide	1024-57-3
188.	Isodrin	465-73-6
189.	Kepone	143-50-0
190.	Methoxyclor	72-43-5
191.	Toxaphene	8001-35-2
	Phenoxyacetic acid herbicides	
192.	2,4-Dichlorophenoxyacetic acid	94-75-7
193.	Silvex	93-72-1
194.	2,4,5-T	93-76-5
	Organophosphorous insecticides	
195.	Disulfoton	298-04-4
196.	Famphur	52-85-7
197.	Methyl parathion	298-00-0
198.	Parathion	56-38-2
199.	Phorate	298-02-2
	PCBs	
200.	Aroclor 1016	12674-11-2
201.	Aroclor 1221	11104-28-2
202.	Aroclor 1232	11141-16-5
203.	Aroclor 1242	53469-21-9
204.	Aroclor 1248	12672-29-6
205.	Aroclor 1254	11097-69-1
206.	Aroclor 1260	11096-82-5

Table 1-1 (Continued)

BDAT reference no.	Constituent	CAS no.
	Dioxins and furans	
207.	Hexachlorodibenzo-p-dioxins	-
208.	Hexachlorodibenzofurans	-
209.	Pentachlorodibenzo-p-dioxins	-
210.	Pentachlorodibenzofurans	-
211.	Tetrachlorodibenzo-p-dioxins	-
212.	Tetrachlorodibenzofurans	-
213.	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6

comprehensive list of hazardous constituents specifically regulated under RCRA. The BDAT list consists of those constituents that can be analyzed using methods published in SW-846, Third Edition.

The initial BDAT constituent list was published in EPA's Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT") in March 1987. Additional constituents are added to the BDAT constituent list as more key constituents are identified for specific waste codes or as new analytical methods are developed for hazardous constituents. For example, since the list was published in March 1987, 18 additional constituents (hexavalent chromium, xylenes (all three isomers), benzal chloride, phthalic anhydride, ethylene oxide, acetone, n-butyl alcohol, 2-ethoxyethanol, ethyl acetate, ethyl benzene, ethyl ether, methanol, methyl isobutyl ketone, 2-nitropropane, 1,1,2-trichloro-1,2,2-trifluoroethane, and cyclohexanone) have been added to the list.

Chemicals are listed in Appendix VIII if they are shown in scientific studies to have toxic, carcinogenic, mutagenic, or teratogenic effects on humans or other life-forms, and they include such substances as those identified by the Agency's Carcinogen Assessment Group as being carcinogenic. A waste can be listed as a toxic waste on the basis that it contains a constituent in Appendix VIII.

Although Appendix VII, Appendix VIII, and the F003 and F005 ignitables provide a comprehensive list of RCRA-regulated hazardous constituents, not all of the constituents can be analyzed in a complex waste matrix. Therefore, constituents that could not be readily analyzed in an unknown waste matrix were not included on the initial BDAT constituent list. As mentioned above, however, the BDAT constituent list is a continuously growing list that does not preclude the addition of new constituents when analytical methods are developed.

There are five major reasons that constituents were not included on the BDAT constituent list:

1. Constituents are unstable. Based on their chemical structure, some constituents will either decompose in water or will ionize. For example, maleic anhydride will form maleic acid when it comes in contact with water, and copper cyanide will ionize to form copper and cyanide ions. However, EPA may choose to regulate the decomposition or ionization products.

2. EPA-approved or verified analytical methods are not available. Many constituents, such as 1,3,5-trinitrobenzene, are not measured adequately or even detected using any of EPA's analytical methods published in SW-846 Third Edition.

3. The constituent is a member of a chemical group designated in Appendix VIII as not otherwise specified (N.O.S.). Constituents listed as N.O.S., such as chlorinated phenols, are a generic group of some types of chemicals for which a single analytical procedure is not available. The individual members of each such group need to be listed to determine whether the constituents can be analyzed. For each N.O.S. group, all those constituents that can be readily analyzed are included in the BDAT constituent list.

4. Available analytical procedures are not appropriate for a complex waste matrix. Some compounds, such as auramine, can be analyzed as a pure constituent. However, in the presence of other constituents, the recommended analytical method does not positively identify the constituent. The use of high performance liquid chromatography (HPLC) presupposes a high expectation of finding the specific constituents of interest. In using this procedure to screen samples, protocols would have to be developed on a case-specific basis to verify the identity of constituents present in the samples. Therefore, HPLC is usually not an appropriate analytical procedure for complex samples containing unknown constituents.

5. Standards for analytical instrument calibration are not commercially available. For several constituents, such as benz(c)acridine, commercially available standards of a "reasonably" pure grade are not available. The unavailability of a standard was determined by a review of catalogs from specialty chemical manufacturers.

Two constituents (fluoride and sulfide) are not specifically included in Appendices VII and VIII; however, these compounds are included on the BDAT list as indicator constituents for compounds from Appendices VII and VIII such as hydrogen fluoride and hydrogen sulfide, which ionize in water.

The BDAT constituent list presented in Table 1-1 is divided into the following nine groups:

- Volatile organics;
- Semivolatile organics;
- Metals;
- Other inorganics;
- Organochlorine pesticides;
- Phenoxyacetic acid herbicides;
- Organophosphorous insecticides;
- PCBs; and
- Dioxins and furans.

The constituents were placed in these categories based on their chemical properties. The constituents in each group are expected to behave similarly during treatment and are also analyzed, with the exception of the metals and the other inorganics, by using the same analytical methods.

(2) Constituent selection analysis. The constituents that the Agency selects for regulation in each waste are, in general, those found in the untreated wastes at treatable concentrations. For certain waste

codes, the target list for the untreated waste may have been shortened (relative to analyses performed to test treatment technologies) because of the extreme unlikelihood that the constituent will be present.

In selecting constituents for regulation, the first step is to develop of list of potentially regulated constituents by summarizing all the constituents that are present or are likely to be present in the untreated waste at treatable concentrations. A constituent is considered present in a waste if the constituent (1) is detected in the untreated waste above the detection limit, (2) is detected in any of the treated residuals above the detection limit, or (3) is likely to be present based on the Agency's analyses of the waste-generating process. In case (2), the presence of other constituents in the untreated waste may interfere with the quantification of the constituent of concern, making the detection limit relatively high and resulting in a finding of "not detected" when, in fact, the constituent is present in the waste. Thus, the Agency reserves the right to regulate such constituents.

After developing a list of potential constituents for regulation, EPA reviews this list to determine if any of these constituents can be excluded from regulation because they would be controlled by regulation of other constituents on the list. This indicator analysis is done for two reasons: (1) it reduces the analytical cost burdens on the treater and (2) it facilitates implementation of the compliance and enforcement program. EPA's rationale for selection of regulated constituents for this waste code is presented in Section 6 of this background document.

(3) Calculation of standards. The final step in the calculation of the BDAT treatment standard is the multiplication of the average accuracy-corrected treatment value by a factor referred to by the Agency as the variability factor. This calculation takes into account that even well-designed and well-operated treatment systems will experience some fluctuations in performance. EPA expects that fluctuations will result from inherent mechanical limitations in treatment control systems, collection of treated samples, and analysis of these samples. All of the above fluctuations can be expected to occur at well-designed and well-operated treatment facilities. Therefore, setting treatment standards utilizing a variability factor should be viewed not as a relaxing of section 3004(m) requirements, but rather as a function of the normal variability of the treatment processes. A treatment facility will have to be designed to meet the mean achievable treatment performance level to ensure that the performance levels remain within the limits of the treatment standard.

The Agency calculates a variability factor for each constituent of concern within a waste treatability group using the statistical calculation presented in Appendix A. The equation for calculating the variability factor is the same as that used by EPA for the development of numerous regulations in the Effluent Guidelines Program under the Clean Water Act. The variability factor establishes the instantaneous maximum based on the 99th percentile value.

There is an additional step in the calculation of the treatment standards in those instances where the ANOVA analysis shows that more than one technology achieves a level of performance that represents BDAT. In such instances, the BDAT treatment standard for each constituent of concern is calculated by first averaging the mean performance value for each technology and then multiplying that value by the highest variability factor among the technologies considered. This procedure ensures that all the technologies used as the basis for the BDAT treatment standards will achieve full compliance.

1.2.5 Compliance with Performance Standards

Usually the treatment standards reflect performance achieved by the best demonstrated available technology (BDAT). As such, compliance with these numerical standards requires only that the treatment level be achieved prior to land disposal. It does not require the use of any particular treatment technology. While dilution of the waste as a means to comply with the standards is prohibited, wastes that are generated in such a way as to naturally meet the standards can be land disposed without treatment. With the exception of treatment standards that prohibit land disposal or that specify use of certain treatment methods. all established treatment standards are expressed as concentration levels.

EPA is using both the total constituent concentration and the concentration of the constituent in the TCLP extract of the treated waste as a measure of technology performance.

For all organic constituents, EPA is basing the treatment standards on the total constituent concentration found in the treated waste. EPA is using this measurement because most technologies for treatment of organics destroy or remove organics compounds. Accordingly, the best measure of performance would be the total amount of constituent remaining after treatment. (NOTE: EPA's land disposal restrictions for solvent waste codes F001-F005 (51 FR 40572) use the TCLP extract value as a measure of performance. At the time that EPA promulgated the treatment standards for F001-F005, useful data were not available on total constituent concentrations in treated residuals, and, as a result, the TCLP data were considered to be the best measure of performance.)

For all metal constituents, EPA is using both total constituent concentration and/or the TCLP extract concentration as the basis for treatment standards. The total constituent concentration is being used when the technology basis includes a metal recovery operation. The underlying principle of metal recovery is that it reduces the amount of metal in a waste by separating the metal for recovery; total constituent concentration in the treated residual, therefore, is an important measure of performance for this technology. Additionally, EPA also believes that it is important that any remaining metal in a treated residual waste not be in a state that is easily leachable; accordingly, EPA is also using the TCLP extract concentration as a measure of performance. It is important to note that for wastes for which treatment standards are based on a metal recovery process, the facility has to comply with both the total and the TCLP extract constituent concentrations prior to land disposing the waste.

In cases where treatment standards for metals are not based on recovery techniques but rather on stabilization, EPA is using only the TCLP value as a measure of performance. The Agency's rationale is that stabilization is not meant to reduce the concentration of metal in a waste but only to chemically minimize the ability of the metal to leach.

1.2.6 Identification of BDAT

BDAT for a waste must be the "best" of the demonstrated available technologies. EPA determines which technology constitutes "best" after screening the available data from each demonstrated technology, adjusting these data for accuracy, and comparing the performance of each demonstrated technology to that of the others. If only one technology is identified as demonstrated, it is considered "best"; if it is available, the technology is BDAT.

(1) Screening of treatment data. The first activity in determining which of the treatment technologies represent treatment by BDAT is to screen the treatment performance data from each of the demonstrated and available technologies according to the following criteria:

1. Design and operating data associated with the treatment data must reflect a well-designed, well-operated system for each treatment data point. (The specific design and operating parameters for each demonstrated technology for the waste code(s) of interest are discussed in Section 3.2 of this document.)

2. Sufficient QA/QC data must be available to determine the true values of the data from the treated waste. This screening criterion involves adjustment of treated data to take into account that the true value may be different from the measured value. This discrepancy generally is caused by other constituents in the waste that can mask results or otherwise interfere with the analysis of the constituent of concern.

3. The measure of performance must be consistent with EPA's approach to evaluating treatment by type of constituents (e.g., total concentration data for organics, and total concentration and TCLP extract concentration for metals from the residual).

In the absence of data needed to perform the screening analysis, EPA will make decisions on a case-by-case basis as to whether to use the data as a basis for the treatment standards. The factors included in this case-by-case analysis will be the actual treatment levels achieved, the availability of the treatment data and their completeness (with respect to the above criteria), and EPA's assessment of whether the untreated waste represents the waste code of concern.

(2) Comparison of treatment data. In cases in which EPA has treatment data from more than one demonstrated available technology following the screening activity, EPA uses the statistical method known as analysis of variance (ANOVA) to determine if one technology performs significantly better than the others. This statistical method (summarized in Appendix A) provides a measure of the differences between two data sets. Specifically, EPA uses the analysis of variance to determine whether BDAT represents a level of performance achieved by only one technology or represents a level of performance achieved by more than one (or all) of the technologies. If EPA finds that one technology performs significantly better (i.e., is "best"), BDAT treatment standards

are the level of performance achieved by that best technology multiplied by the corresponding variability factor for each regulated constituent. If the Agency finds that the levels of performance for one or more technologies are not statistically different, EPA averages the performance values achieved by each technology and then multiplies this value by the largest variability factor associated with any of the technologies.

(3) Quality assurance/quality control. This section presents the principal quality assurance/quality control (QA/QC) procedures employed in screening and adjusting the data to be used in the calculation of treatment standards. Additional QA/QC procedures used in collecting and screening data for the BDAT program are presented in EPA's Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT"), EPA/530-SW-87-011.

To calculate the treatment standards for the land disposal restriction rules, it is first necessary to determine the recovery value for each constituent (the amount of constituent recovered after spiking--which is the addition of a known amount of the constituent--minus the initial concentration in the samples, all divided by the spike amount added) for each spiked sample of the treated residual. Once the recovery values are determined, the following procedures are used to select the appropriate percent recovery value to adjust the analytical data:

1. If duplicate spike recovery values are available for the constituent of interest, the data are adjusted by the lowest available percent recovery value (i.e., the value that will yield the most conservative estimate of treatment achieved). However, if a spike recovery value of less than 20 percent is reported for a specific constituent, the data are not used to set treatment standards because the Agency does not have sufficient confidence in the reported value to set a national standard.

2. If data are not available for a specific constituent but are available for an isomer, then the spike recovery data are transferred from the isomer and the data are adjusted using the percent recovery selected according to the procedure described in (1) above.

3. If data are not available for a specific constituent but are available for a similar class of constituents (e.g., volatile organics, acid-extractable semivolatiles), then spike recovery data available for this class of constituents are transferred. All spike recovery values greater than or equal to 20 percent for a spike sample are averaged and the constituent concentration is adjusted by the average recovery value. If spiked recovery data are available for more than one sample, the average is calculated for each sample and the data are adjusted by using the lowest average value.

4. If matrix spike recovery data are not available for a set of data to be used to calculate treatment standards, then matrix spike recovery data are transferred from a waste that the Agency believes is similar (e.g., if the data represent an ash from incineration, then data from other incinerator ashes could be used). While EPA recognizes that transfer of matrix spike recovery data from a similar waste is not an exact analysis, this is considered the best approach for adjusting the data to account for the fact that most analyses do not result in extraction of 100 percent of the constituent. In assessing the recovery data to be transferred, the procedures outlined in (1), (2), and (3) above are followed.

The analytical procedures employed to generate the data used to calculate the treatment standards are listed in Appendix B of this document. In cases where alternatives or equivalent procedures and/or equipment are allowed in EPA's SW-846, Third Edition methods, the specific procedures and equipment used are documented. In addition, any deviations from the SW-846, Third Edition methods used to analyze the specific waste matrices are documented. It is important to note that the Agency will use the methods and procedures delineated in Appendix B to enforce the treatment standards presented in Section 7 of this document. Accordingly, facilities should use these procedures in assessing the performance of their treatment systems.

1.2.7 BDAT Treatment Standards for "Derived-From" and "Mixed" Wastes

(1) Wastes from treatment trains generating multiple residues. In a number of instances, the proposed BDAT consists of a series of operations, each of which generates a waste residue. For example, the proposed BDAT for a certain waste code is based on solvent extraction, steam stripping, and activated carbon adsorption. Each of these treatment steps generates a waste requiring treatment--a solvent-containing stream from solvent extraction, a stripper overhead, and spent activated carbon. Treatment of these wastes may generate further residues; for instance, spent activated carbon (if not regenerated) could be incinerated, generating an ash and possibly a scrubber water waste. Ultimately, additional wastes are generated that may require land disposal. With respect to these wastes, the Agency wishes to emphasize the following points:

1. All of the residues from treating the original listed wastes are likewise considered to be the listed waste by virtue of the derived-from rule contained in 40 CFR 261.3(c)(2). (This point is discussed more fully in (2) below.) Consequently, all of the wastes generated in the course of treatment would be prohibited from land disposal unless they satisfy the treatment standard or meet one of the exceptions to the prohibition.

2. The Agency's proposed treatment standards generally contain a concentration level for wastewaters and a concentration level for nonwastewaters. The treatment standards apply to all of the wastes generated in treating the original prohibited waste. Thus, all derived-from wastes meeting the Agency definition of wastewater (less than 1 percent total organic carbon (TOC) and less than 1 percent total suspended solids) would have to meet the treatment standard for wastewaters. All residuals not meeting this definition would have to meet the treatment standard for nonwastewaters. EPA wishes to make clear that this approach is not meant to allow partial treatment in order to comply with the applicable standard.

3. The Agency has not performed tests, in all cases, on every waste that can result from every part of the treatment train. However, the Agency's treatment standards are based on treatment of the most concentrated form of the waste. Consequently, the Agency believes that the less concentrated wastes generated in the course of treatment will also be able to be treated to meet this value.

(2) Mixtures and other derived-from residues. There is a further question as to the applicability of the BDAT treatment standards to residues generated not from treating the waste (as discussed above), but from other types of management. Examples are contaminated soil or leachate that is derived from managing the waste. In these cases, the mixture is still deemed to be the listed waste, either because of the derived-from rule (40 CFR 261.3(c)(2)(i)) or the mixture rule (40 CFR 261.3(a)(2)(iii) and (iv)) or because the listed waste is contained in the matrix (see, for example, 40 CFR 261.33(d)). The prohibition for the particular listed waste consequently applies to this type of waste.

The Agency believes that the majority of these types of residues can meet the treatment standards for the underlying listed wastes (with the possible exception of contaminated soil and debris for which the Agency is currently investigating whether it is appropriate to establish a separate treatability subcategorization). For the most part, these residues will be less concentrated than the original listed waste. The Agency's treatment standards also make a generous allowance for process variability by assuming that all treatability values used to establish the standard are lognormally distributed. The waste also might be amenable to a relatively nonvariable form of treatment technology such as incineration. Finally, and perhaps most important, the rules contain a treatability variance that allows a petitioner to demonstrate that its waste cannot be treated to the level specified in the rule (40 CFR Part 268.44(a)). This provision provides a safety valve that allows persons with unusual waste matrices to demonstrate the appropriateness of a different standard. The Agency, to date, has not received any petitions under this provision (for example, for residues contaminated with a prohibited solvent waste), indicating, in the Agency's view, that the existing standards are generally achievable.

(3) Residues from managing listed wastes or that contain listed wastes. The Agency has been asked if and when residues from managing hazardous wastes, such as leachate and contaminated ground water, become subject to the land disposal prohibitions. Although the Agency believes this question to be settled by existing rules and interpretative statements, to avoid any possible confusion the Agency will address the question again.

Residues from managing First Third wastes, listed California List wastes, and spent solvent and dioxin wastes are all considered to be subject to the prohibitions for the listed hazardous waste as originally generated. Residues from managing California List wastes likewise are subject to the California List prohibitions when the residues themselves exhibit a characteristic of hazardous waste. This determination stems directly from the derived-from rule in 40 CFR 261.3(c)(2) or, in some cases, from the fact that the waste is mixed with or otherwise contains the listed waste. The underlying principle stated in all of these provisions is that listed wastes remain listed until delisted.

The Agency's historic practice in processing delisting petitions that address mixing residuals has been to consider them to be the listed waste and to require that delisting petitioners address all constituents for which the derived-from waste (or other mixed waste) was listed. The language in 40 CFR 260.22(b) states that mixtures or derived-from residues can be delisted provided a delisting petitioner makes a demonstration identical to that which a delisting petitioner would make for the original listed waste. Consequently, these residues are treated as the original listed waste for delisting purposes. The statute likewise takes this position, indicating that soil and debris that are contaminated with listed spent solvents or dioxin wastes are subject to the prohibition for these wastes even though these wastes are not the originally generated waste, but rather are a residual from management (RCRA section 3004(e)(3)). It is EPA's view that all such residues are covered by the existing prohibitions and treatment standards for the listed hazardous waste that these residues contain or from which they are derived.

1.2.8 Transfer of Treatment Standards

EPA is proposing some treatment standards that are not based on testing of the treatment technology on the specific waste subject to the treatment standard. The Agency has determined that the constituents present in the untested waste can be treated to the same performance levels as those observed in other wastes for which EPA has previously developed treatment data. EPA believes that transferring treatment performance data for use in establishing treatment standards for untested wastes is technically valid in cases where the untested wastes are generated from similar industries or processing steps, or have similar waste characteristics affecting performance and treatment selection. Transfer of treatment standards to similar wastes or wastes from similar processing steps requires little formal analysis. However, in a case where only the industry is similar, EPA more closely examines the waste characteristics prior to deciding whether the untested waste constituents can be treated to levels associated with tested wastes.

EPA undertakes a two-step analysis when determining whether constituents in the untested wastes can be treated to the same level of performance as in the tested waste. First, EPA reviews the available waste characterization data to identify those parameters that are expected to affect treatment selection. EPA has identified some of the most important constituents and other parameters needed to select the treatment technology appropriate for the given waste(s) in Section 3.

Second, when analysis suggests that an untested waste can be treated with the same technology as a waste for which treatment performance data are already available, EPA analyzes a more detailed list of characteristics that the Agency believes will affect the performance of the technology. By examining and comparing these characteristics, the Agency determines whether the untested wastes will achieve the same level of treatment as the tested waste. Where the Agency determines that the untested waste can be treated as well or better than the tested waste, the treatment standards can be transferred.

1.3 Variance from the BDAT Treatment Standard

The Agency recognizes that there may exist unique wastes that cannot be treated to the level specified as the treatment standard. In such a case, a generator or owner/operator may submit a petition to the Administrator requesting a variance from the treatment standard. A particular waste may be significantly different from the wastes on which the treatment standards are based because the subject waste contains a more complex matrix that makes it more difficult to treat. For example, complex mixtures may be formed when a restricted waste is mixed with other waste streams by spills or other forms of inadvertent mixing. As a result, the treatability of the restricted waste may be altered such that it cannot meet the applicable treatment standard.

Variance petitions must demonstrate that the treatment standard established for a given waste cannot be met. This demonstration can be made by showing that attempts to treat the waste by available technologies were not successful or by performing appropriate analyses of the waste, including waste characteristics affecting performance, which demonstrate that the waste cannot be treated to the specified levels. Variances will not be granted based solely on a showing that adequate BDAT treatment capacity is unavailable. (Such demonstrations can be made according to the provisions in Part 268.5 of RCRA for case-by-case extensions of the effective date.) The Agency will consider granting generic petitions provided that representative data are submitted to support a variance for each facility covered by the petition.

Petitioners should submit at least one copy to:

The Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

An additional copy marked "Treatability Variance" should be submitted to:

Chief, Waste Treatment Branch
Office of Solid Waste (WH-565)
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Petitions containing confidential information should be sent with only the inner envelope marked "Treatability Variance" and "Confidential Business Information" and with the contents marked in accordance with the requirements of 40 CFR Part 2 (41 FR 36902, September 1, 1976, amended by 43 FR 4000).

The petition should contain the following information:

1. The petitioner's name and address.
2. A statement of the petitioner's interest in the proposed action.
3. The name, address, and EPA identification number of the facility generating the waste, and the name and telephone number of the plant contact.
4. The process(es) and feed materials generating the waste and an assessment of whether such process(es) or feed materials may produce a waste that is not covered by the demonstration.
5. A description of the waste sufficient for comparison with the waste considered by the Agency in developing BDAT, and an estimate of the average and maximum monthly and annual quantities of waste covered by the demonstration. (Note: The petitioner should consult the appropriate BDAT background document for determining the characteristics of the wastes considered in developing treatment standards.)
6. If the waste has been treated, a description of the system used for treating the waste, including the process design and operating conditions. The petition should include the reasons the treatment standards are not achievable and/or why the petitioner believes the standards are based on inappropriate technology for treating the waste. (Note: The petitioner should refer to the BDAT background document as guidance for determining the design and operating parameters that the Agency used in developing treatment standards.)
7. A description of the alternative treatment systems examined by the petitioner (if any); a description of the treatment system deemed appropriate by the petitioner for the waste in question; and, as appropriate, the concentrations in the treatment residual or extract of the treatment residual (i.e., using the TCLP, where appropriate, for stabilized metals) that can be achieved by applying such treatment to the waste.
8. A description of those parameters affecting treatment selection and waste characteristics that affect performance, including results of all analyses. (See Section 3 for a discussion of

waste characteristics affecting performance that the Agency has identified for the technology representing BDAT.)

9. The dates of the sampling and testing.
10. A description of the methodologies and equipment used to obtain representative samples.
11. A description of the sample handling and preparation techniques, including techniques used for extraction, containerization, and preservation of the samples.
12. A description of analytical procedures used, including QA/QC methods.

After receiving a petition for a variance, the Administrator may request any additional information or waste samples that may be required to evaluate and process the petition. Additionally, all petitioners must certify that the information provided to the Agency is accurate under 40 CFR 268.4(b).

In determining whether a variance will be granted, the Agency will first look at the design and operation of the treatment system being used. If EPA determines that the technology and operation are consistent with BDAT, the Agency will evaluate the waste to determine if the waste matrix and/or physical parameters are such that the BDAT treatment standards reflect treatment of this waste. Essentially, this latter analysis will concern the parameters affecting treatment selection and waste characteristics affecting performance parameters.

In cases where BDAT is based on more than one technology, the petitioner will need to demonstrate that the treatment standard cannot be met using any of the technologies, or that none of the technologies are appropriate for treatment of the waste. After the Agency has made a determination on the petition, the Agency's findings will be published in the Federal Register, followed by a 30-day period for public comment. After review of the public comments, EPA will publish its final determination in the Federal Register as an amendment to the treatment standards in 40 CFR Part 268, Subpart D.

2. INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

The previous section provided the background for the Agency's study of K101 and K102 wastes. The purpose of this section is to describe the industry that will be affected by land disposal restrictions on waste codes K101 and K102 and to characterize these wastes. This section includes a description of the industry affected and the production processes employed in this industry. Also included is a discussion of how K101 and K102 wastes are generated by these processes. This section concludes with a characterization of the K101 and K102 wastes and a determination of the waste treatability group for these wastes.

The full list of hazardous waste codes from specific sources is given in 40 CFR 261.32 (see discussion in Section 1 of this document). Within this list, two specific hazardous waste codes are generated by the veterinary pharmaceuticals industry.

K101: Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo- arsenic compounds.

K102: Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.

The Agency has determined that these waste codes (K101 and K102) represent a separate waste treatability group. This was established because they originate from the same industry and similar processes: K102 in the production process and K101 in the treatment process of production wastewaters. In addition, the same treatment technologies apply to both waste codes. As a result, the Agency has examined the sources of the wastes, applicable treatment technologies, and treatment performance attainable in order to support a single regulatory approach for the two wastes.

2.1 Industry Affected and Process Description

The four-digit standard industrial classification (SIC) code reported for the veterinary pharmaceuticals industry is 2834. The Agency has identified two facilities in the United States that are actively involved in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds which could generate K101 and K102 wastes. Information from the listing background document and from facility contacts provides a geographic distribution of these facilities across the United States. The two facilities involved in producing arsenic-based veterinary pharmaceuticals are located in northeast Iowa and southwest North Carolina.

As identified by EPA, the processes that use arsenic or organo-arsenic compounds are the production of 3-nitro- and 4-nitro-4-hydroxyphenylarsonic acid (3-nitro, 4-nitro). The manufacture of 3-nitro requires the reaction of an organic compound with inorganic arsenic to form the organo-arsenic product. The listed waste K102 is generated in the production process. Details of the production process are considered to be Confidential Business Information (CBI) and are not presented here.[*] (See Figure 2-1.)

The wastewaters and floor washings generated from 3-Nitro exhibit the characteristics of EP toxicity for arsenic. These wastewaters are classified by EPA as D004 characteristic waste.[**] In the treatment of the wastes from the production process, two listed wastes, K084 and K101, are generated (see Figure 2-2).

2.1.1 Generation of K102 Waste

The product stream from the reactor in the 3-nitro-4-hydroxyphenylarsonic acid process goes to a hydrolysis tank where carbon and caustic soda are added to decolor the product stream. The decolorized stream from the hydrolysis tank is filtered in a filter press. The spent carbon removed is the listed waste K102. The filtrate from the filtering step undergoes additional steps and the product, 3-nitro-4-hydroxyphenylarsonic acid, is recovered. (See Figure 2-1.)

2.1.2 Generation of K101 Waste

The listed waste K101 is generated in the treatment of wastewaters originating from the production of arsenic-containing veterinary pharmaceuticals. (See Figure 2-2.) The wastewaters, D004, are treated in a series of steps. First, the wastewaters are precipitated using caustic

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[*] Details of the production of 3-nitro are in the RCRA CBI Docket.

[**] Throughout the remainder of this document, this characteristic waste will be referred to simply as D004.

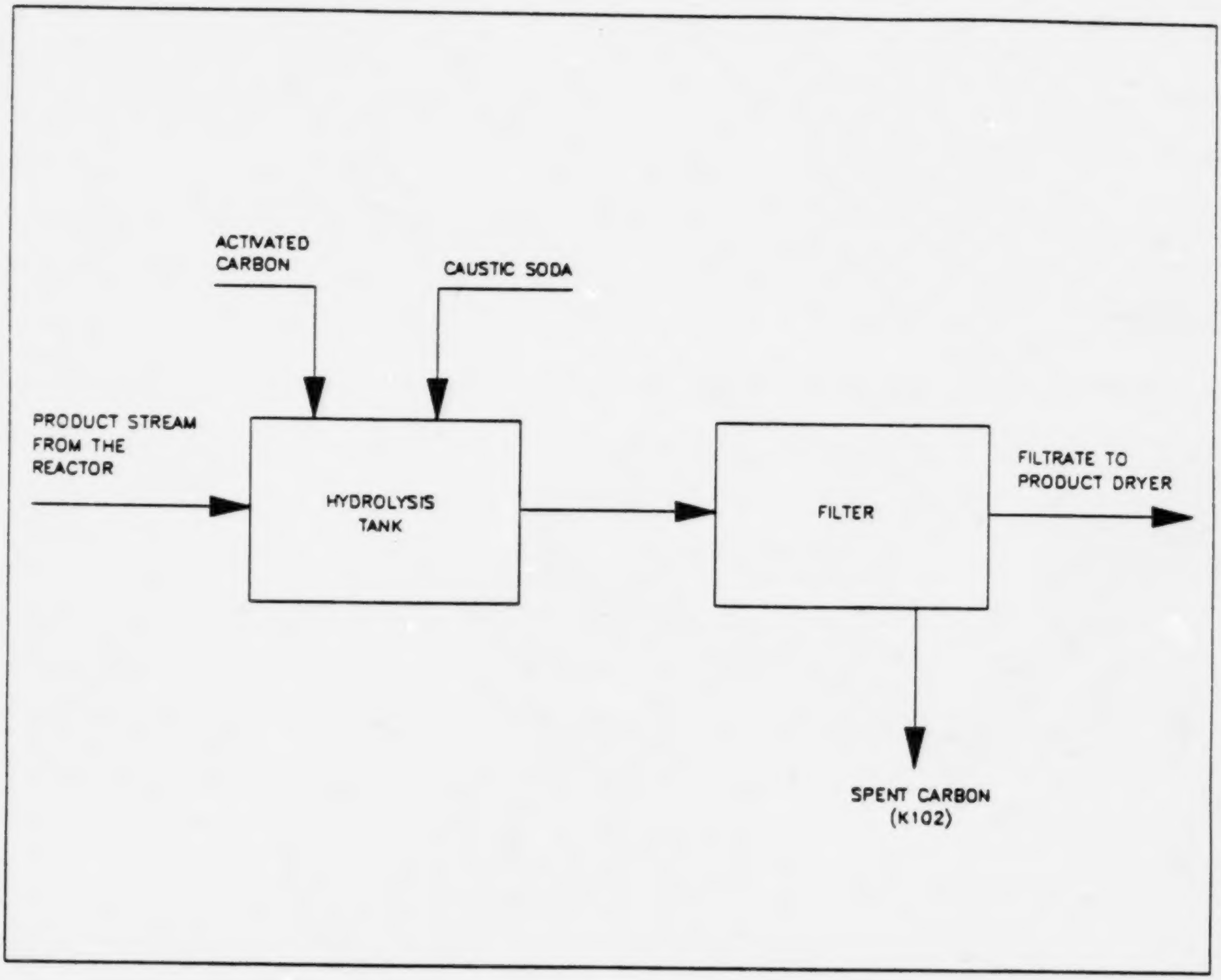

ACTIVATED CARBON
CAUSTIC SODA
PRODUCT STREAM FROM THE REACTOR
HYDROLYSIS TANK
FILTER
FILTRATE TO PRODUCT DRYER
SPENT CARBON (K102)

FIGURE 2-1

GENERATION OF K102 FROM 3-NITRO-4-HYDROXYPHENYLARSONIC ACID PRODUCTION

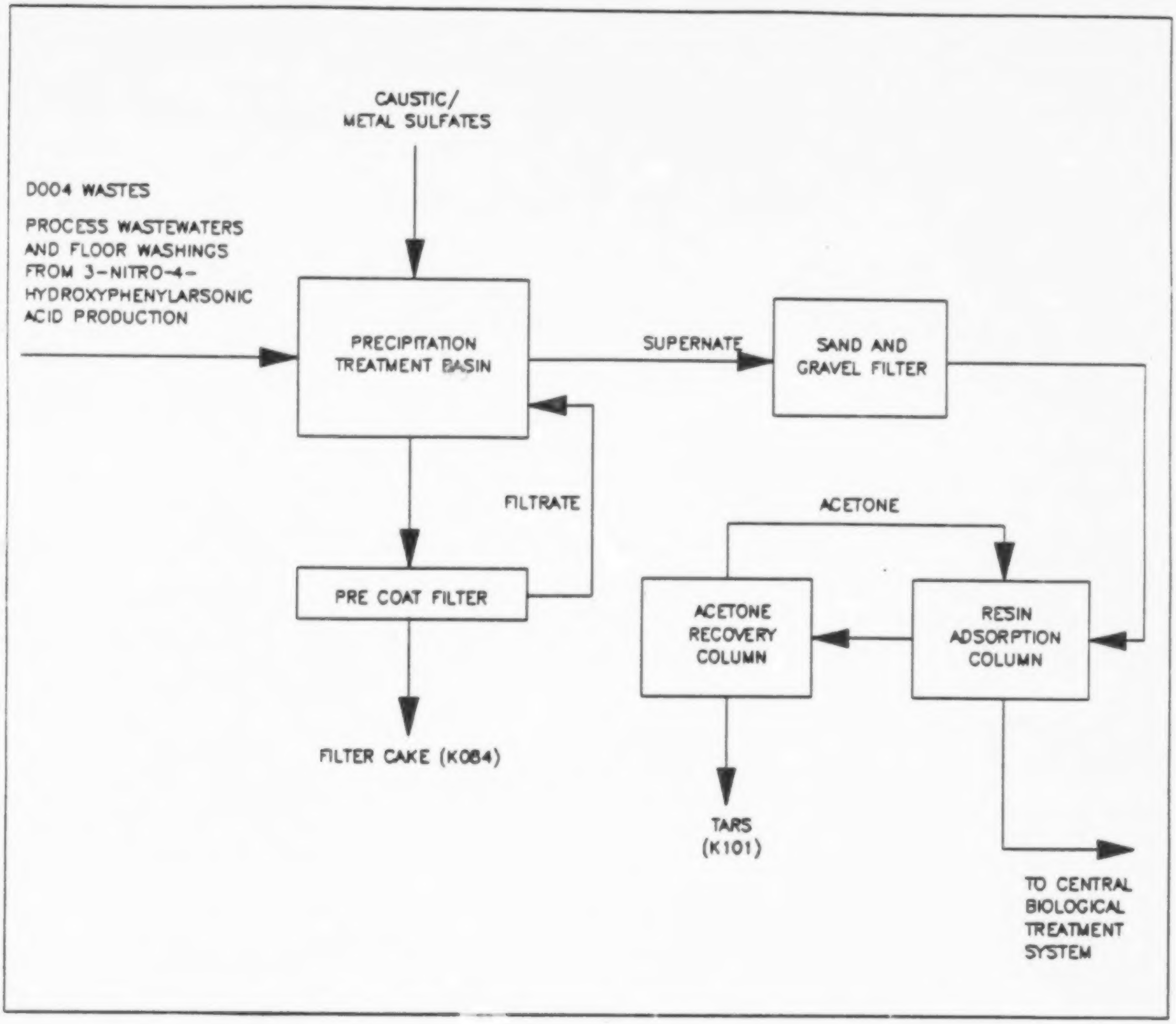

CAUSTIC/
METAL SULFATES
D004 WASTES
PROCESS WASTEWATERS AND FLOOR WASHINGS FROM 3-NITRO-4-HYDROXYPHENYLARSONIC ACID PRODUCTION
PRECIPITATION TREATMENT BASIN
SUPERNATE
SAND AND GRAVEL FILTER
FILTRATE
PRE COAT FILTER
FILTER CAKE (K084)
ACETONE
ACETONE RECOVERY COLUMN
RESIN ADSORPTION COLUMN
TARS (K101)
TO CENTRAL BIOLOGICAL TREATMENT SYSTEM

FIGURE 2-2

GENERATION OF K084 AND K101 FROM THE TREATMENT OF D004 WASTES and metal sulfates. The precipitated salts generated are the listed waste K084. Second, the supernate from the chemical precipitation step passes through a sand and gravel filter to remove undissolved solids. Third, the filtered supernate passes through a resin adsorption column designed to remove ortho-nitroaniline (2-nitroanaline) and ortho-nitrophenol (2-nitrophenol). The resin adsorption column is regenerated with acetone. The acetone used for this regeneration is distilled in an acetone recovery column. The clay-like tars generated in the distillation are the listed waste K101.

2.2 Waste Characterization

This section includes all waste characterization data available to the Agency for the K101 and K102 wastes. An estimate of the major constituents in these wastes and their approximate concentrations are presented in Table 2-1. The percent concentration of each major constituent in the wastes was determined from best estimates based on chemical analyses. Table 2-1 shows that the major constituent of K101 is the clay-like tar from the acetone recovery column (78 percent). BDAT list organics and metals each are present in less than 1 percent in K101. The non-BDAT list organic, 2-nitroaniline, accounts for 20 percent of K101 waste. The major constituent present in K102 is spent activated carbon (97 percent). BDAT organics account for less than 1 percent of the K102 waste. BDAT metals are present in K102 at less than 2 percent, with arsenic and antimony being the majority of metals present.

Table 2-1

Major Constituent Composition for K101 Waste[a]

Constituent	Weight percent in K101
BDAT organics	<1
BDAT metals	<1
2-Nitroaniline	<20
Clay-like tar	>78
	100

Major Constituent Composition for K102 Waste[a]

Constituent	Weight percent in K102
BDAT organics	<1
Arsenic	<1
Other BDAT metals (primarily antimony)	<1
Spent activated carbon	>97
	100

[a] Percent concentrations presented here were determined from best estimates based on chemical analyses.

Reference: USEPA 1988a and USEPA 1988b.

The ranges of BDAT constituents present in each waste and all other available data concerning waste characterization parameters, obtained from the Onsite Engineering Reports for John Zink Company, Tulsa, Oklahoma, are presented by waste code in Table 2-2. This table lists the ranges of BDAT organics (volatile and semivolatile), metals, and inorganics other than metals present in K101 and K102 wastes. Other parameters analyzed in the wastes include non-BDAT organics, chlorides, sulfates, total solids, total suspended solids, total dissolved solids, and total organic carbon.

TABLE 2-2 BDAT CONSTITUENT ANALYSIS AND OTHER DATA FOR WASTE CODES K101 AND K102 [a]

		Untreated K101 Waste Concentration Ranges (mg/kg)	Untreated K102 Waste Concentration Ranges (mg/kg)
BDAT			
	Volatile Organics		
222	Acetone	<50 - 81	ND
43	Toluene	<25 - 42	5.4 - 26
215-217	Total Xylenes	ND	<1.5 - 5.3
	Semivolatile Organics		
70	Bis(2-ethylhexyl)Phthalate	<36,000 - <38,000	<19.4 - <194
142	Phenol	ND	<19.4 - <194
	Metals		
154	Antimony	<3.3 - 7.4	8,960 - 18,800
155	Arsenic	590 - 1,950	3,060 - 8,320
156	Barium	3.5 - 108	16 - 52
157	Beryllium	<0.1	<0.10 - 0.20
158	Cadmium	<5.0	8.9 - 26
159	Chromium	2.0 - 22	16 - 22
160	Copper	128 - 289	4.7 - 6.6
161	Lead	<0.5 - 6.7	1.6 - 25.9
162	Mercury	1.5 - 4.2	<0.1 - 3.5
163	Nickel	1.8 - 5.4	<1.1 - 13
164	Selenium	<0.5	9.1 - 17
165	Silver	<0.7 - 1.6	<0.7
166	Thallium	<5.0	<1.0 - 2.1
167	Vanadium	<0.4 - 1.7	<0.40 - 0.58
168	Zinc	35 - 111	3.1 - 8.7
	Inorganics		
169	Cyanide	<0.67	3.21 - 5.06
170	Fluoride	7.74**	4.35**
171	Sulfide	65.6 - 778	4,250 - 8,150
NON-BDAT			
*	2-Nitroaniline	<172,000 - 191,000	ND
*	2-Nitrophenol	ND	220 - 870
	Chlorides	9,960 - 38,700	336 - 7,080
	Sulfates	5,690 - 11,800	37 - 338
	Total Solids	604,000 - 804,000	333,000 - 395,000
	Total Suspended Solids	NA	NA
	Total Dissolved Solids	NA	NA
	Total Organic Carbon	254,900 - 407,400	163,100 - 216,500

a - Obtained from Onsite Engineering Report, John Zink Company, Tulsa, Oklahoma, for K101 and K102. Tables 5-3 through 5-6 and 5-3 through 5-8, respectively.

* - This constituent is not on the list of constituents in the GENERIC QUALITY ASSURANCE PROJECT PLAN FOR LAND DISPOSAL RESTRICTIONS PROGRAM ("BDAT"), EPA/530-SW-87-011, March 1987. It is a groundwater monitoring constituent as listed in Appendix IX, 40 CFR Part 264, 51 FR 26639, July 24, 1986.

** - This constituent was analyzed in only one sample set.

NA - Not analyzed.

ND - Not detected.

3. APPLICABLE/DEMONSTRATED TREATMENT TECHNOLOGIES

The purpose of this section is to describe applicable treatment technologies for treatment of K101 and K102 wastes that the Agency has identified as applicable and to describe which of the applicable technologies the Agency has determined to be demonstrated. Included in this section are discussions of those applicable treatment technologies that have been demonstrated on a commercial basis. The technologies that were considered to be applicable are those which treat organic compounds by concentration reduction.

The previous section described the industry that will be affected by restrictions on the K102 waste and presented a characterization of this waste. Characterization of the K102 waste indicates that this waste primarily consists of spent activated carbon (greater than 97 percent), BDAT list organics (less than 1 percent), and BDAT list metals (less than 2 percent). Analysis of K101 waste indicates that this waste primarily consists of 2-nitroaniline (less than 20 percent), a clay-like tar (greater than 78 percent), BDAT list organics (less than 1 percent), and BDAT list metals (less than 1 percent). The Agency has identified these treatment technologies that may be applicable to K101 and K102 because the technologies are designed to reduce the concentration of organic compounds present in the untreated waste. The selection of the treatment technologies applicable for treating organic compounds in K101 and K102 wastes is based on information obtained from engineering site visits and available literature sources.

3.1 Applicable Treatment Technologies

For K101 and K102 nonwastewater, the Agency has identified the following treatment technologies as being applicable: rotary kiln incineration (which thermally destroys organic components in the waste) followed by metals stabilization of the resulting kiln ash (which reduces leachability of metal components by binding the metals to the solid matrix).

For K101 and K102 wastewaters, namely, the scrubber waters generated from treatment by rotary kiln incineration, the Agency has identified the following treatment technology as being applicable: chemical precipitation (which removes dissolved metals by addition of a treatment chemical to form a metal precipitate).

Chemical precipitation of the scrubber waters generates a residual. The precipitated metals represent an inorganic form of the nonwastewaters. The kiln ash is also an inorganic form of K101 and K102 nonwastewaters and the applicable treatment technology is metals stabilization. Therefore, the applicable technology for chemical precipitated residuals from scrubber waters is metals stabilization.

3.2 Demonstrated Treatment Technologies

3.2.1 Nonwastewaters

The current treatment practices for both wastes K101 and K102 in the veterinary pharmaceutical industry are (1) incineration followed by land disposal or (2) stabilization followed by land disposal. The Agency, therefore, believes that incineration and stabilization are applicable for treating K101 and K102 wastes. However, the Agency does not believe that either incineration or stabilization alone is the best treatment for K101 and K102 wastes.

The Agency believes that rotary kiln incineration of organic nonwastewaters and metals stabilization of inorganic nonwastewaters are demonstrated for K101 and K102 because these technologies have been used on a commercial basis to treat wastes with characteristics affecting treatment performance that are similar to those of K101 and K102. While the Agency has performance data for incineration treatment for K101 and K102 organic nonwastewaters, it did not collect performance data for metals stabilization of the inorganic K101 and K102 nonwastewaters.

3.2.2 Wastewaters

Chemical precipitation has not been demonstrated for K101 and K102 wastewaters. Chemical precipitation has been demonstrated in wastewaters similar to those from K101 and K102 with regard to parameters affecting treatment selection. Therefore, the Agency has determined that chemical precipitation of wastewaters is demonstrated. However, the Agency did not collect performance data for chemical precipitation of K101 and K102 wastewaters.

3.3 Detailed Description of Treatment Technologies

More detailed discussions of the treatment technologies for which the Agency has collected performance data are presented in Sections 3.3.1, 3.3.2, and 3.3.3.

3.3.1 Incineration

This section addresses the commonly used incineration technologies: liquid injection, rotary kiln, fluidized bed incineration, and fixed hearth. A discussion is provided regarding the applicability of these technologies, the underlying principles of operation, a technology description, waste characteristics that affect performance, and, finally, important design and operating parameters. The subsections are divided by type of incineration unit, as appropriate.

(1) Applicability and Use of Incineration.

(a) Liquid injection. Liquid injection is applicable to wastes that have viscosity values low enough that the waste can be atomized in the combustion chamber. A range of literature maximum viscosity values is reported, with the low being 100 SSU and the high being 10,000 SSU. It is important to note that viscosity is temperature-dependent, so that while liquid injection may not be applicable to a waste at ambient conditions, it may be applicable when the waste is heated. Other factors that affect the use of liquid injection are particle size and the presence of suspended solids. Both of these waste parameters can cause plugging of the burner nozzle.

(b) Rotary kiln/fluidized bed/fixed hearth. These incineration technologies are applicable to a wide range of hazardous wastes. They can be used on wastes that contain high or low total organic content, high or low filterable solids, various viscosity ranges, and a range of other waste parameters. EPA has not found these technologies to be demonstrated on wastes that are comprised essentially of metals with low organic concentrations. In addition, the Agency expects that some of the high metal content wastes may not be compatible with existing and future air emission limits without emission controls far more extensive than are currently practiced.

(2) Underlying Principles of Operation.

(a) Liquid injection. The basic operating principle of this incineration technology is that incoming liquid wastes are volatilized, then additional heat is supplied to the waste to destabilize the chemical bonds. Once the chemical bonds are broken, these constituents react with oxygen to form carbon dioxide and water vapor. The energy needed to destabilize the bonds is referred to as the energy of activation.

(b) Rotary kiln and fixed hearth. There are two distinct principles of operation for these incineration technologies, one for each of the chambers involved. In the primary chamber, energy, in the form of heat, is transferred to the waste to achieve volatilization of the various organic waste constituents. During this volatilization process some of the organic constituents will oxidize to carbon dioxin and water vapor. In the secondary chamber, additional heat is supplied to overcome the energy requirements needed to destabilize the chemical bonds and allow the constituents to react with excess oxygen to form carbon dioxide and water vapor. The principle of operation for the secondary chamber is similar to that for liquid injection.

(c) Fluidized bed. The principle of operation for this incinerator technology differs somewhat from that for rotary kiln and fixed hearth incineration relative to the functions of the primary and secondary chambers. In fluidized bed incineration, the primary chamber not only volatilizes the waste but also essentially combusts it. Destruction of the waste organics can be better accomplished in the primary chamber of this technology than in the primary chambers of the rotary kiln and fixed hearth technologies because (1) fluidization of the waste using forced air improves heat transfer and (2) fluidization provides sufficient oxygen and turbulence to convert the organics to carbon dioxide and water vapor. The secondary chamber (referred to as the freeboard) generally does not have an afterburner; however, additional time is provided to convert the organic constituents to carbon dioxide, water vapor, and hydrochloric acid if chlorine is present in the waste.

(3) Description of incineration technologies.

(a) Liquid injection. The liquid injection system is capable of incinerating a wide range of gases and liquids. The combustion system has a simple design with virtually no moving parts. A burner or nozzle atomizes the liquid waste and injects it into the combustion chamber where it burns in the presence of air or oxygen. A forced draft system supplies the combustion chamber with air to provide oxygen for combustion and turbulence for mixing. The combustion chamber is usually a cylinder lined with refractory (i.e., heat resistant) brick and can be fired horizontally, vertically upward, or vertically downward. Figure 3-1 illustrates a liquid injection incineration system.

(b) Rotary kiln. A rotary kiln is a slowly rotating, refractory-lined cylinder that is mounted at a slight incline from the horizontal (see Figure 3-2). Solid wastes enter at the high end of the kiln, and liquid or gaseous wastes enter through atomizing nozzles in the kiln or afterburner section. Rotation of the kiln exposes the solids to the heat, vaporizes them, and allows them to combust by mixing with air. The rotation also causes the ash to move to the lower end of the kiln where it can be removed. Rotary kiln systems usually have a secondary combustion chamber or afterburner following the kiln for further combustion of the volatilized components of solid wastes.

(c) Fluidized bed. A fluidized bed incinerator consists of a column containing inert particles such as sand, which is referred to as the bed. Air, driven by a blower, enters the bottom of the bed to fluidize the sand. Air passage through the bed promotes rapid and uniform mixing of the injected waste material within the fluidized bed. The fluidized bed has an extremely high heat capacity (approximately three times that of flue gas at the same temperature), thereby providing a large heat reservoir. The injected waste reaches ignition temperature quickly and transfers the heat of combustion back to the bed. Continued bed agitation by the fluidizing air allows larger particles to remain suspended in the combustion zone. (See Figure 3-3.)

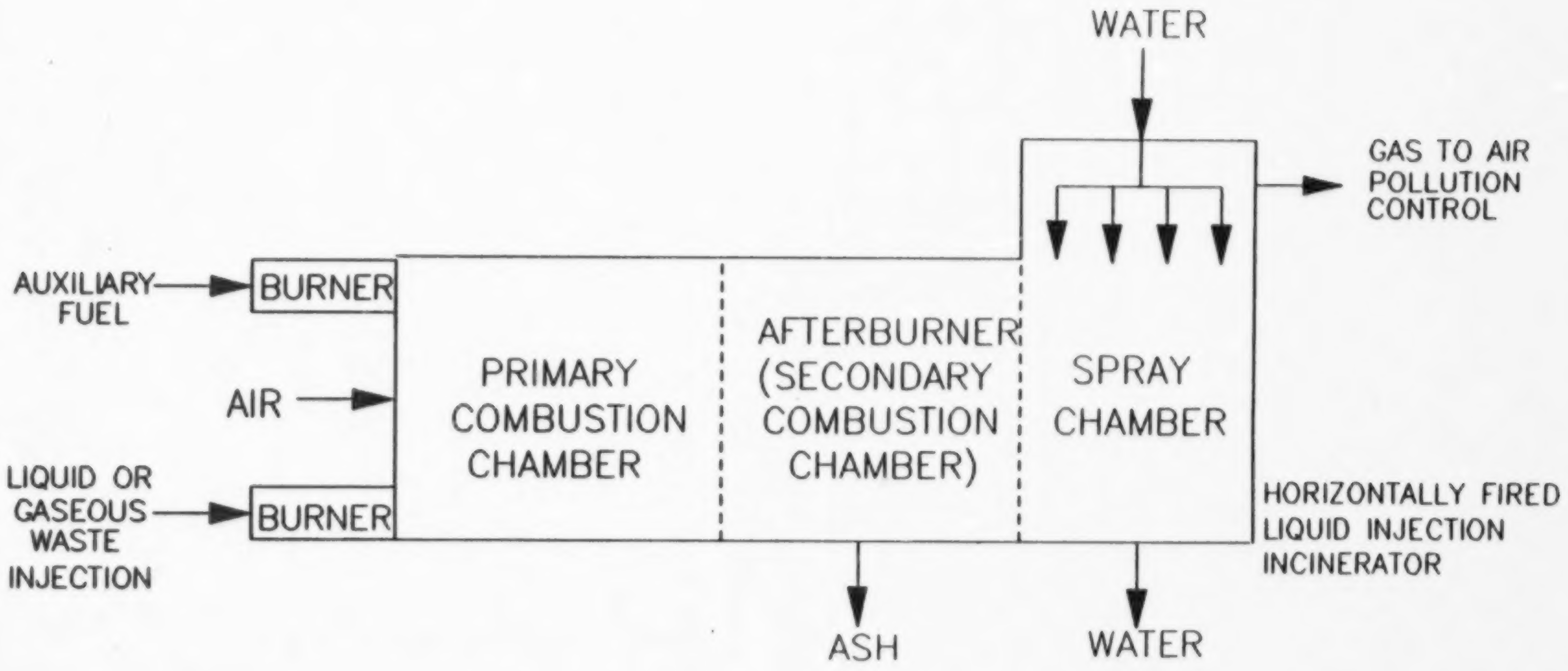

WATER
GAS TO AIR POLLUTION CONTROL
AUXILIARY FUEL
BURNER
AIR
LIQUID OR GASEOUS WASTE INJECTION
BURNER
PRIMARY COMBUSTION CHAMBER
AFTERBURNER (SECONDARY COMBUSTION CHAMBER)
SPRAY CHAMBER
HORIZONTALLY FIRED LIQUID INJECTION INCINERATOR
ASH
WATER

FIGURE 3-1
LIQUID INJECTION INCINERATOR

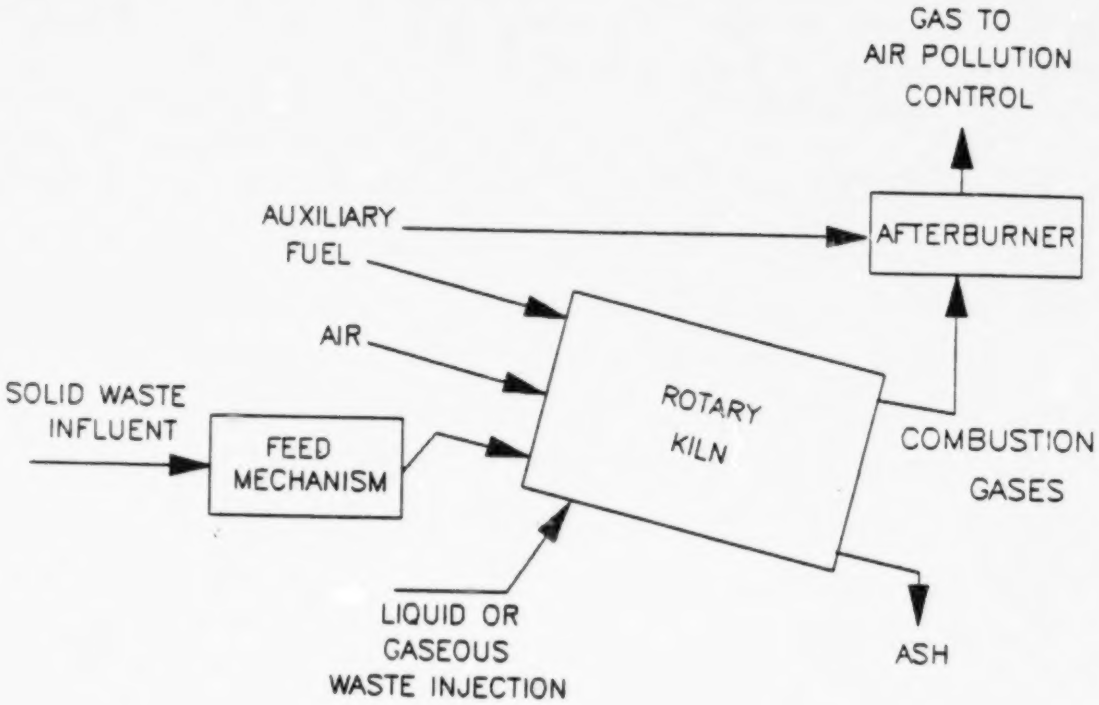

GAS TO
AIR POLLUTION
CONTROL
AUXILIARY
FUEL
AFTERBURNER
AIR
SOLID WASTE
INFLUENT
FEED
MECHANISM
ROTARY
KILN
COMBUSTION
GASES
LIQUID OR
GASEOUS
WASTE INJECTION
ASH

FIGURE 3–2 ROTARY KILN INCINERATOR

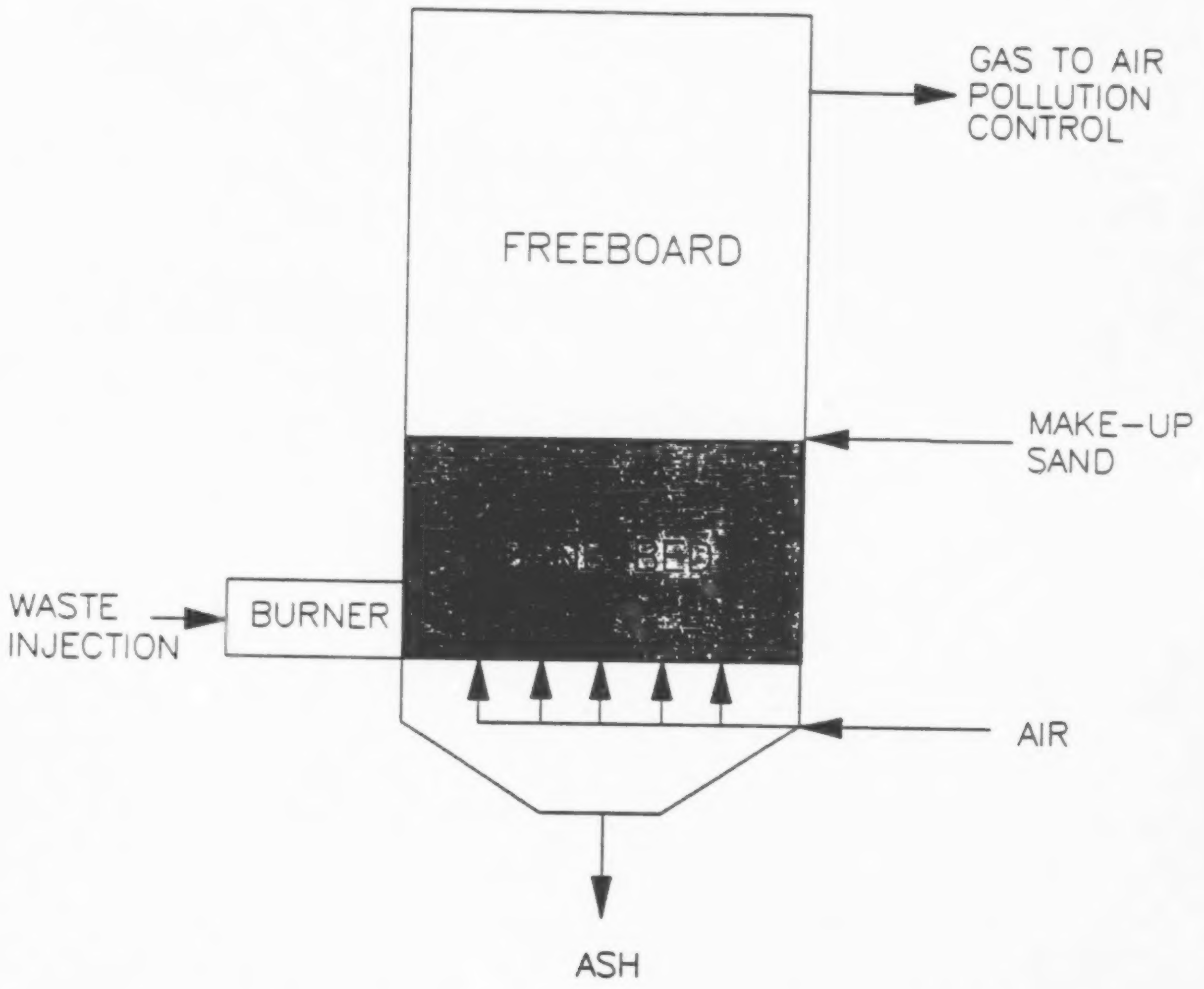

GAS TO AIR POLLUTION CONTROL
FREEBOARD
MAKE-UP SAND
SAND BED
WASTE INJECTION
BURNER
AIR
ASH

FIGURE 3-3

FLUIDIZED BED INCINERATOR

(d) Fixed hearth incineration. Fixed hearth incinerators, also called controlled air or starved air incinerators, are another major technology used for hazardous waste incineration. Fixed hearth incineration is a two-stage combustion process. (See Figure 3-4.) Waste is ram-fed into the first stage, or primary chamber, then burned at less than stoichiometric conditions. The resultant smoke and pyrolysis products, consisting primarily of volatile hydrocarbons and carbon monoxide, along with the normal products of combustion, pass to the secondary chamber. Here, additional air is injected to complete the combustion. This two-stage process generally yields low stack particulate and carbon monoxide (CO) emissions. The primary chamber combustion reactions and combustion gas are maintained at low levels by the starved air conditions so that particulate entrainment and carryover are minimized.

(e) Air pollution controls. Following incineration of hazardous wastes, combustion gases are generally further treated in an air pollution control system. The presence of chlorine or other halogens in the waste requires a scrubbing or absorption step to remover hydrogen chloride and other halo-acids from the combustion gases. Ash in the waste is not destroyed in the combustion process. Depending on its composition, ash will either exit as bottom ash, at the discharge end of a kiln or hearth for example, or as particulate matter (fly ash) suspended in the combustion gas stream. Particulate emissions from most hazardous waste combustion systems generally have particle diameters of less than 1 micron and require high efficiency collection devices to

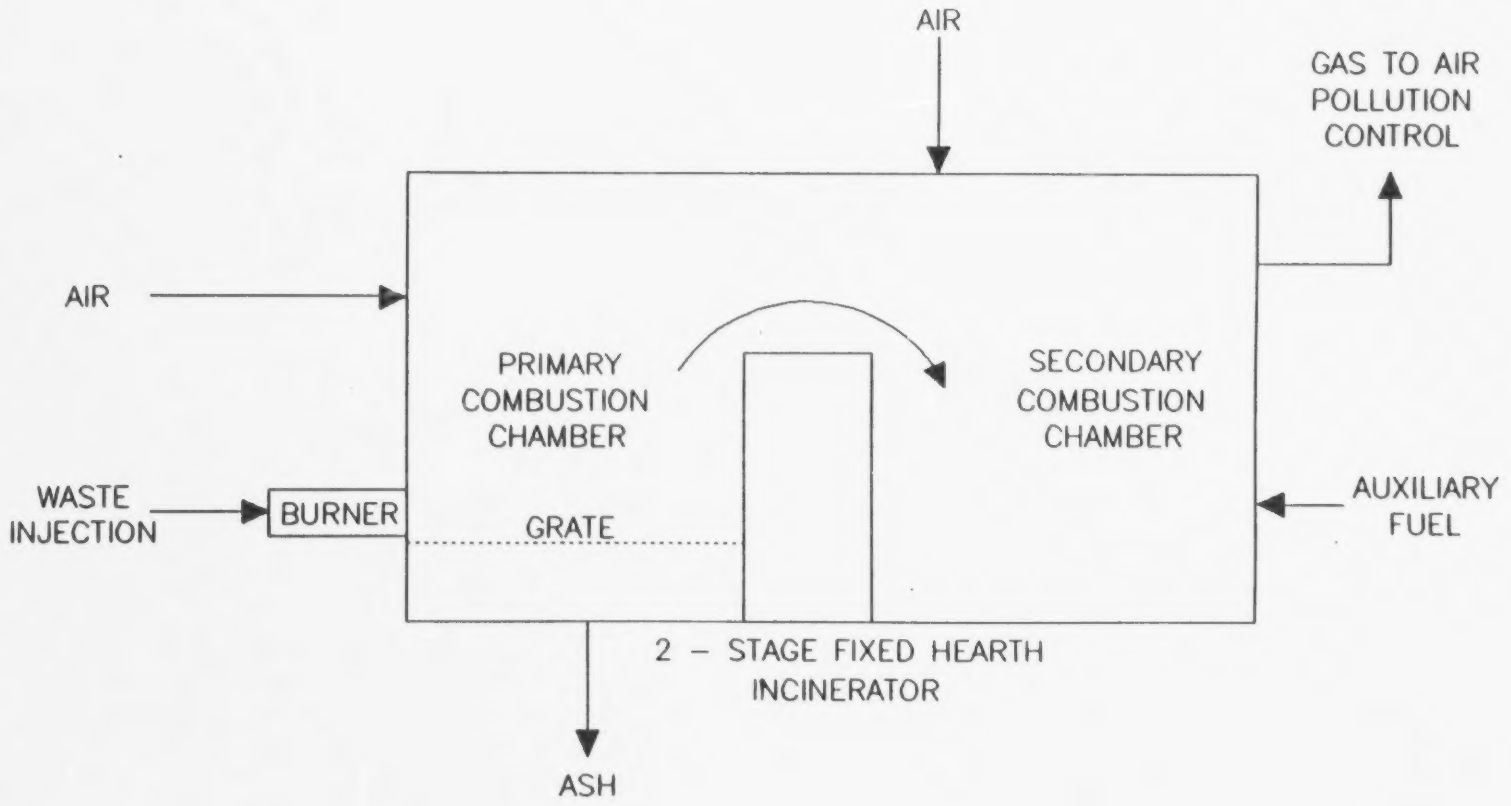

AIR
GAS TO AIR
POLLUTION
CONTROL
AIR
PRIMARY
COMBUSTION
CHAMBER
SECONDARY
COMBUSTION
CHAMBER
WASTE
INJECTION
BURNER
GRATE
AUXILIARY
FUEL
2 – STAGE FIXED HEARTH
INCINERATOR
ASH

FIGURE 3–4 FIXED HEARTH INCINERATOR

minimize air emissions. In addition, scrubber systems provide an additional buffer against accidental releases of incompletely destroyed waste products caused by poor combustion efficiency or combustion upsets, such as flameouts.

(4) Waste characteristics affecting performance.

(a) Liquid injection. In determining whether liquid injection is likely to achieve the same level of performance on an untested waste as on a previously tested waste, the Agency will compare dissociation bond energies of the constituents in the untested and tested waste. This parameter is being used as a surrogate indicator of activation energy which, as discussed previously, destabilizes molecular bonds. In theory, the bond dissociation energy would be equal to the activation energy; in practice, however, this is not always the case. Other energy effects (e.g., vibrational, the formation of intermediates, and interactions between different molecular bonds) may have a significant influence on activation energy.

Because of the shortcomings of bond energies in estimating activation energy, EPA analyzed other waste characteristic parameters to determine whether these parameters would provide a better basis for transferring treatment standards from an untested waste to a tested waste. These parameters include heat of combustion, heat of formation, use of available kinetic data to predict activation energies, and general structural class. All of these parameters were rejected for the reasons provided below.

The heat of combustion measures only the difference in energy of the products and reactants; it does not provide information on the transition state (i.e., the energy input needed to initiate the reaction). Heat of formation is used as a predictive tool for determining whether reactions are likely to proceed; however, there are a significant number of hazardous constituents for which these data are not available. Use of kinetic data was rejected because these data are limited and could not be used to calculate free energy values (ΔG) for the wide range of hazardous constituents to be addressed by this rule. Finally, EPA decided not to use structural classes because the Agency believes that evaluation of bond dissociation energies allows for a more direct determination of whether a constituent will be destabilized.

(b) Rotary kiln/fluidized bed/fixed hearth. Unlike liquid injection, these incineration technologies also generate a residual ash. Accordingly, in determining whether these technologies are likely to achieve the same level of performance on an untested waste as on a previously tested waste, EPA would need to examine the waste characteristics that affect volatilization of organics from the waste, as well as destruction of the organics once volatilized. Relative to volatilization, EPA will examine thermal conductivity of the entire waste and boiling point of the various constituents. As with liquid injection, EPA will examine bond energies in determining whether treatment standards for scrubber water residuals can be transferred from a tested waste to an untested waste. Below is a discussion of how EPA arrived at thermal conductivity and boiling point as the best method to assess volatilization of organics from the waste; the discussion relative to bond energies is the same for these technologies as for liquid injection and will not be repeated here.

(i) Thermal conductivity. Consistent with the underlying principles of incineration, a major factor with regard to whether a particular constituent will volatilize is the transfer of heat through the waste. In the case of rotary kiln, fluidized bed, and fixed hearth incineration, heat is transferred through the waste by three mechanisms: radiation, convection, and conduction. For a given incinerator, heat transferred through various wastes by radiation is more a function of the design and type of incinerator than of the waste being treated. Accordingly, the type of waste treated will have a minimal impact on the amount of heat transferred by radiation. With regard to convection, EPA also believes that the type of heat transfer will generally be more a function of the type and design of the incinerator than of the waste itself. However, EPA is examining particle size as a waste characteristic that may significantly impact the amount of heat transferred to a waste by convection and thus impact volatilization of the various organic compounds. The final type of heat transfer, conduction, is the one that EPA believes will have the greatest impact on volatilization of organic constituents. To measure this characteristic, EPA will use thermal conductivity; an explanation of this parameter, as well as how it can be measured, is provided below.

Heat flow by conduction is proportional to the temperature gradient across the material. The proportionality constant is a property of the material and is referred to as thermal conductivity. (Note: The analytical method that EPA has identified for measurement of thermal conductivity is named "Guarded, Comparative, Longitudinal Heat Flow Technique"; it is described in Appendix E.) In theory, thermal conductivity would always provide a good indication of whether a constituent in an untested waste would be treated to the same extent in the primary incinerator chamber as the same constituent in a previously tested waste.

In practice, thermal conductivity has some limitations in assessing the transferability of treatment standards; however, EPA has not identified a parameter that can provide a better indication of the heat transfer characteristics of a waste. Below is a discussion of both the limitations associated with thermal conductivity and the other parameters considered.

Thermal conductivity measurements, as part of a treatability comparison for two different wastes through a single incinerator, are most meaningful when applied to wastes that are homogeneous (i.e., major constituents are essentially the same). As wastes exhibit greater degrees of nonhomogeneity (e.g., significant concentration of metals in soil), then thermal conductivity becomes less accurate in predicting treatability because the measurement essentially reflects heat flow through regions having the greatest conductivity (i.e., the path of least resistance), not heat flow through all parts of the waste.

The thermal conductivities for the listed wastes, K101 and K102, were determined by the "Guarded, Comparative, Longitudinal Heat Flow Technique." This method and the results for K101 and K102 are discussed in Appendix E. The thermal conductivities for K101 and K102 were determined to be 0.273 W/mK and 0.136 W/mK, respectively.

Btu value, specific heat, and ash content were also considered for predicting heat transfer characteristics. These parameters can no better account for nonhomogeneity than can thermal conductivity; additionally, they are not directly related to heat transfer characteristics. Therefore, these parameters do not provide a better indication of heat transfer that will occur in any specific waste.

(ii) Boiling point. Once heat is transferred to a constituent within a waste, then removal of this constituent from the waste will depend on its volatility. As a surrogate of volatility, EPA is using boiling point of the constituent. Compounds with lower boiling points have higher vapor pressures and therefore would be more likely to vaporize. The Agency recognizes that this parameter does not take into consideration the impact of other compounds in the waste on the boiling point of a constituent in a mixture; however, the Agency is not aware of a better measure of volatility that can be easily determined. The boiling points for 2-nitroaniline and 2-nitrophenol are 284°C and 216°C, respectively.

(5) Design and Operating Parameters.

(a) Liquid injection. For a liquid injection unit, EPA's analysis of whether the unit is well-designed will focus on (1) the likelihood that sufficient energy is provided to the waste to overcome the activation level for breaking molecular bonds, and (2) whether sufficient oxygen is present to convert the waste constituents to carbon dioxide and water vapor. The specific design parameters that the Agency will evaluate to assess whether these conditions are met are temperature, excess oxygen, and residence time. Below is a discussion of why EPA believes these parameters to be important, as well as a discussion of how these parameters will be monitored during operation.

It is important to point out that relative to the development of land disposed restriction standards, EPA is only concerned with these design parameters when a quench water or scrubber water residual is generated from treatment of a particular waste. If treatment of a particular waste in a liquid injection unit would not generate a wastewater stream, then the Agency, for purposes of land disposal treatment standards, would only be concerned with the waste characteristics that affect selection of the unit, not the above-mentioned design parameters.

(i) Temperature. Temperature is important because it provides an indirect measure of the energy available (i.e., Btus/hr) to overcome the activation energy of waste constituents. As the design temperature increases, the more likely it is that the molecular bonds will be destabilized and the reaction completed.

The temperature is normally controlled automatically through the use of instrumentation that senses the temperature and automatically adjusts the amount of fuel and/or waste being fed. The temperature signal transmitted to the controller can be simultaneously transmitted to a recording device, referred to as a strip chart, and thereby can be continuously recorded. To fully assess the operation of the unit, it is important to know not only the exact location in the incinerator that the temperature is being monitored but also the location of the design temperature.

(ii) Excess oxygen. It is important that the incinerator contain oxygen in excess of the stoichiometric amount necessary to convert the organic compounds to carbon dioxide and water vapor. If insufficient oxygen is present, then destabilized waste constituents could recombine to the same or other BDAT list organic compounds and potentially cause the scrubber water to contain higher concentrations of BDAT list constituents than would be the case for a well-operated unit.

In practice, the amount of oxygen fed to the incinerator is controlled by continuous sampling and analysis of the stack gas. If the amount of oxygen drops below the design value, then the analyzer transmits a signal to the valve controlling the air supply and thereby increases the flow of oxygen to the afterburner. The analyzer simultaneously transmits a signal to a recording device so that the amount of excess oxygen can be continuously recorded. Again, as with temperature, it is important to know the location from which the combustion gas is being sampled.

(iii) Carbon monoxide. Carbon monoxide is an important operating parameter because it provides an indication of the extent to which the waste organic constituents are being converted to carbon dioxide and water vapor. As the carbon monoxide level increases, it indicates that larger amounts of organic waste constituents are unreacted or partially reacted. Increased carbon monoxide levels can result from insufficient excess oxygen, insufficient turbulence in the combustion zone, or insufficient residence time.

(iv) Waste feed rate. The waste feed rate is important to monitor because it is correlated to the residence time. The residence time is associated with a specific Btu energy value of the feed and a specific volume of combustion gas generated. Prior to incineration, the Btu value of the waste is determined through the use of a laboratory device known as a bomb calorimeter. The volume of combustion gas generated from the waste to be incinerated is determined from an analysis referred to as an ultimate analysis. This analysis determines the amount of elemental constituents present; these constituents include carbon, hydrogen, sulfur, oxygen, nitrogen, and halogens. Using this analysis plus the total amount of air added, the volume of combustion gas can be calculated. Having determined both the Btu content and the expected combustion gas volume, the feed rate can be fixed at the desired residence time. Continuous monitoring of the feed rate will determine whether the unit was operated at a rate corresponding to the designed residence time.

(b) Rotary kiln. For this incineration, EPA will examine both the primary and secondary chamber in evaluating the design of a particular incinerator. Relative to the primary chamber, EPA's assessment of design will focus on whether sufficient energy is likely to be provided to the waste in order to volatilize the waste constituents. For the secondary chamber, analogous to the sole liquid injection incineration chamber, EPA will examine the same parameters discussed under liquid injection incineration. These parameters will not be discussed again here.

The particular design parameters to be evaluated for the primary chamber are kiln temperature, residence time, and revolutions per minute. Below is a discussion of why EPA believes these parameters to be important, as well as a discussion of how these parameters will be monitored during operation.

(i) Temperature. The primary chamber temperature is important since it provides an indirect measure of the energy input (i.e., Btu/hr) that is available for heating the waste. The higher the temperature is designed to be in a given kiln, the more likely it is that the constituents will volatilize. As discussed earlier under "Liquid Injection," temperature should be continuously monitored and recorded. Additionally, it is important to know the location of the temperature sensing device in the kiln.

(ii) Residence time. This parameter affects whether sufficient heat is transferred to a particular constituent in order for volatilization to occur. As the time that the waste in the kiln is increased, a greater quantity of heat is transferred to the hazardous waste constituents. The residence time will be a function of the specific configuration of the rotary kiln, including the length and diameter of the kiln, the waste feed rate, and the rate of rotation.

(iii) Revolutions per minute (RPM). This parameter provides an indication of the turbulence that occurs in the primary chamber of a rotary kiln. As the turbulence increases, the quantity of heat transferred to the waste would also be expected to increase. However, as the RPM value increases, the residence time decreases, resulting in a reduction of the quantity of heat transferred to the waste. This parameter needs to be carefully evaluated because it provides a balance between turbulence and residence time.

(c) Fluidized bed. As discussed in the section on "Underlying Principles of Operation," the primary chamber accounts for almost all of the conversion of organic wastes to carbon dioxide, water vapor, and acid gas if halogens are present. The secondary chamber will generally provide additional residence time for thermal oxidation of the waste constituents. Relative to the primary chamber, the parameters that the Agency will examine in assessing the effectiveness of the design are temperature, residence time, and bed pressure differential. The first two were discussed under rotary kiln and will not be discussed here. The third parameter, bed pressure differential, is important because it provides an indication of the amount of turbulence and, therefore, indirectly the amount of heat supplied to the waste. In general, as the pressure drop increases, both the turbulence and heat supplied increase. The pressure drop through the bed should be monitored continuously and recorded to ensure that the designed valued is achieved.

(d) Fixed hearth. The design considerations for this incineration unit are similar to those for a rotary kiln, except that rate of rotation (i.e., RPM) is not an applicable design parameter. For the primary chamber of this unit, the parameters that the Agency will examine in assessing how well the unit is designed are the same as those discussed under rotary kiln; for the secondary chamber (i.e., afterburner), the design and operating parameters of concern are the same as those discussed under "Liquid Injection."

3.3.2 Stabilization of Metals

Stabilization refers to a broad class of treatment processes that chemically reduce the mobility of hazardous constituents in a waste. Solidification and fixation are other terms that are sometimes used synonymously for stabilization or to describe specific variations within the broader class of stabilization. Related technologies are encapsulation and thermoplastic binding; however, EPA considers these technologies to be distinct from stabilization since their operational principles differ significantly.

(1) Applicability and use of stabilization. Stabilization is used when a waste contains metals that will leach from the waste when it is contacted by water. In general, this technology is applicable to wastes that contain BDAT list metals and have a high filterable solids content, low TOC content, and low oil and grease content. This technology is commonly used to treat residuals generated from treatment of electroplating wastewaters. For some wastes, an alternative to stabilization is metal recovery.

(2) Underlying principles of operation. The basic principle underlying this technology is that stabilizing agents and other chemicals are added to a waste to minimize the amount of metal that leaches. The reduced leachability is accomplished by the formation of a lattice structure and/or chemical bonds that bind the metals to the solid matrix and thereby limit the amount of metal constituents that can be leached when water or a mild acid solution comes into contact with the waste material.

The two principal stabilization processes used are cement- based and lime-based processes. A brief discussion of each is provided below. In both cement-based or lime/pozzolan-based techniques, the stabilizing process can be modified through the use of additives, such as silicates, that control curing rates or enhance the properties of the solid material.

(a) Portland cement-based process. Portland cement is a mixture of powdered oxides of calcium, silica, aluminum, and iron, produced by kiln burning of materials rich in calcium and silica at high temperatures (i.e., 1400 to 1500°C). When the anhydrous cement powder is mixed with water, hydration occurs and the cement begins to set. The chemistry involved is complex because many different reactions occur depending on the composition of the cement mixture.

As the cement begins to set, a colloidal gel of indefinite composition and structure is formed. Over time, the gel swells and forms a matrix composed of interlacing, thin, densely packed silicate fibrils. Constituents present in the waste slurry (e.g., hydroxides and carbonates of various heavy metals) are incorporated into the interstices of the cement matrix. The high pH of the cement mixture tends to keep metals in the form of insoluble hydroxide and carbonate salts. It has been hypothesized that metal ions may also be incorporated into the crystal structure of the cement matrix, but this hypothesis has not been verified.

(b) Lime/pozzolan-based process. Pozzolan, which contains finely divided, noncrystalline silica (e.g., fly ash or components of cement kiln dust), is a material that is not cementitious in itself, but becomes so upon the addition of lime. Metals in the waste are converted to silicates or hydroxides, which inhibit leaching. Additives, again, can be used to reduce permeability and thereby further decrease leaching potential.

(3) Description of stabilization processes. In most stabilization processes, the waste, stabilizing agent, and other additives, if used, are mixed and then pumped to a curing vessel or area and allowed to cure. The actual operation (equipment requirements and process

sequencing) will depend on several factors such as the nature of the waste, the quantity of the waste, the location of the waste in relation to the disposal site, the particular stabilization formulation to be used, and the curing rate. After curing, the solid formed is recovered from the processing equipment and shipped for final disposal.

In instances where waste contained in a lagoon is to be treated, the material should be first transferred to mixing vessels where stabilizing agents are added. The mixed material is then fed to a curing pad or vessel. After curing, the solid formed is removed for disposal. Equipment commonly used also includes facilities to store waste and chemical additives. Pumps can be used to transfer liquid or light sludge wastes to the mixing pits and pumpable uncured wastes to the curing site. Stabilized wastes are then removed to a final disposal site.

Commercial concrete mixing and handling equipment generally can be used with wastes. Weighing conveyors, metering cement hoppers, and mixers similar to concrete batching plants have been adapted in some operations. Where extremely dangerous materials are being treated, remote-control and in-drum mixing equipment, such as that used with nuclear waste, can be employed.

(4) Waste characteristics affecting performance. In determining whether stabilization is likely to achieve the same level of performance on an untested waste as on a previously tested waste, the Agency will focus on the characteristics that inhibit the formation of either the chemical bonds or the lattice structure. The four characteristics EPA

has identified as affecting treatment performance are the presence of (1) fine particulates, (2) oil and grease, (3) organic compounds, and (4) certain inorganic compounds.

(a) Fine particulates. For both cement-based and lime/pozzolan-based processes, the literature states that very fine solid materials (i.e., those that pass through a No. 200 mesh sieve, 74 um particle size) can weaken the bonding between waste particles and cement by coating the particles. This coating can inhibit chemical bond formation and can decrease the resistance of the material to leaching.

(b) Oil and grease. The presence of oil and grease in both cement-based and lime/pozzolan-based systems results in the coating of waste particles and the weakening of the bonding between the particle and the stabilizing agent. This coating can inhibit chemical bond formation and thereby decrease the resistance of the material to leaching.

(c) Organic compounds. The presence of organic compounds in the waste interferes with the chemical reactions and bond formation that inhibit curing of the stabilized material. This results in a stabilized waste that has decreased resistance to leaching. The total organic carbon content for K101 and K102 nonwastewaters is 267 to 2,130 mg/kg for K101 and 24,200 to 422,000 mg/kg for K102.

(d) Sulfate and chlorides. The presence of certain inorganic compounds will interfere with the chemical reactions, weakening bond strength and prolonging setting and curing time. Sulfate and chloride compounds may reduce the dimensional stability of the cured matrix, thereby increasing leachability potential.

Accordingly, EPA will examine these constituents when making decisions regarding transfer of treatment standards based on stabilization. The amounts of sulfate in K101 and K102 nonwastewaters are 148 to 193 mg/kg and 12 to 55.9 mg/kg, respectively. Chlorides are present at 8.7 to 11.1 mg/kg in K101 and 71.5 to 103 mg/kg in K102.

(5) Design and operating parameters. In designing a stabilization system, the principal parameters that are important to optimize so that the amount of leachable metal constituents is minimized are (1) selection of stabilizing agents and other proprietary additives, (2) ratio of waste to stabilizing agents and other additives, (3) degree of mixing, and (4) curing conditions.

(a) Selection of stabilizing agents and other additives. The stabilizing agent and additives used will determine the chemistry and structure of the stabilized material and therefore will affect the leachability of the solid material. Stabilizing agents and additives must be carefully selected based on the chemical and physical characteristics of the waste to be stabilized. For example, the amount of sulfates in a waste must be considered when a choice is being made between a lime/pozzolan and a portland cement-based system.

To select the type of stabilizing agents and additives, the waste should be tested in the laboratory with a variety of materials to determine the best combination.

(b) Amount of stabilizing agents and additives. The amount of stabilizing agents and additives is a critical parameter in that sufficient stabilizing materials are necessary in the mixture to bind the waste constituents of concern properly, thereby making them less susceptible to leaching. The appropriate weight ratios of waste to stabilizing agent and other additives are established empirically by setting up a series of laboratory tests that allow separate leachate testing of different mix ratios. The ratio of water to stabilizing agent (including water in waste) will also impact the strength and leaching characteristics of the stabilized material. Too much water will cause low strength; too little will make mixing difficult and, more important, may not allow the chemical reactions that bind the hazardous constituents to be fully completed.

(c) Mixing. The conditions of mixing include the type and duration of mixing. Mixing is necessary to ensure homogeneous distribution of the waste and the stabilizing agents. Both undermixing and overmixing are undesirable. The first condition results in a nonhomogeneous mixture; therefore, areas will exist within the waste where waste particles are neither chemically bonded to the stabilizing agent nor physically held within the lattice structure. Overmixing, on the other hand, may inhibit gel formation and ion adsorption in some stabilization systems. As with the relative amounts of waste, stabilizing agent, and additives within the system, optimal mixing conditions generally are determined through laboratory tests. During treatment it is important to monitor the degree (i.e., type and duration) of mixing to ensure that it reflects design conditions.

(d) Curing conditions. The curing conditions include the duration of curing and the ambient curing conditions (temperature and humidity). The duration of curing is a critical parameter to ensure that the waste particles have had sufficient time in which to form stable chemical bonds and/or lattice structures. The time necessary for complete stabilization depends upon the waste type and the stabilization used. The performance of the stabilized waste (i.e., the levels of constituents in the leachate) will be highly dependent upon whether complete stabilization has occurred. Higher temperatures and lower humidity increase the rate of curing by increasing the rate of evaporation of water from the solidification mixtures. However, if temperatures are too high, the evaporation rate can be excessive and result in too little water being available for completion of the stabilization reaction. The duration of the curing process should also be determined during the design stage and typically will be between 7 and 28 days.

3.3.3 Chemical Precipitation

(1) Applicability and use of chemical precipitation. Chemical precipitation is used when dissolved metals are to be removed from solution. This technology can be applied to a wide range of wastewaters containing dissolved BDAT list metals and other metals as well. This treatment process has been practiced widely by industrial facilities since the 1940s.

(2) Underlying principles of operation. The underlying principle of chemical precipitation is that metals in wastewater are removed by the addition of a treatment chemical that converts the dissolved metal to a metal precipitate. This precipitate is less soluble than the original metal compound and therefore settles out of solution, leaving a lower concentration of the metal present in the solution. The principal chemicals used to convert soluble metal compounds to the less soluble forms include lime ($Ca(OH)_2$), caustic (NaOH), sodium sulfide (Na_2S), and, to a lesser extent, soda ash (Na_2CO_3), phosphate, and ferrous sulfide (FeS).

The solubility of a particular compound will depend on the extent to which the electrostatic forces holding the ions of the compound together can be overcome. The solubility will change significantly with temperature; most metal compounds are more soluble as the temperature increases. Additionally, the solubility will be affected by the other constituents present in a waste. As a general rule, nitrates, chlorides, and sulfates are more soluble than hydroxides, sulfides, carbonates, and phosphates.

An important concept related to treatment of the soluble metal compounds is pH. This term provides a measure of the extent to which a solution contains either an excess of hydrogen or hydroxide ions. The pH scale ranges from 0 to 14, with 0 being the most acidic, 14 representing the highest alkalinity or hydroxide ion (OH^-) content, and 7.0 being neutral.

When hydroxide is used, as is often the case, to precipitate the soluble metal compounds, the pH is frequently monitored to ensure that sufficient treatment chemicals are added. It is important to point out that pH is not a good measure of treatment chemical addition for compounds other than hydroxides. When sulfide is used, for example, facilities might use an oxidation-reduction potential meter (ORP) correlation to ensure that sufficient treatment chemical is used.

Following conversion of the relatively soluble metal compounds to metal precipitates, the effectiveness of chemical precipitation is a function of the physical removal, which usually relies on a settling process. A particle of a specific size, shape, and composition will settle at a specific velocity, as described by Stokes' Law. For a batch system, Stokes' Law is a good predictor of settling time because the pertinent particle parameters essentially remain constant. Nevertheless, in practice, settling time for a batch system is normally determined by empirical testing. For a continuous system, the theory of settling is complicated by factors such as turbulence, short-circuiting, and velocity gradients, increasing the importance of the empirical tests.

(3) Description of chemical precipitation. The equipment and instrumentation required for chemical precipitation varies depending on whether the system is batch or continuous. Both operations are discussed below; a schematic of the continuous system is shown in Figure 3-5.

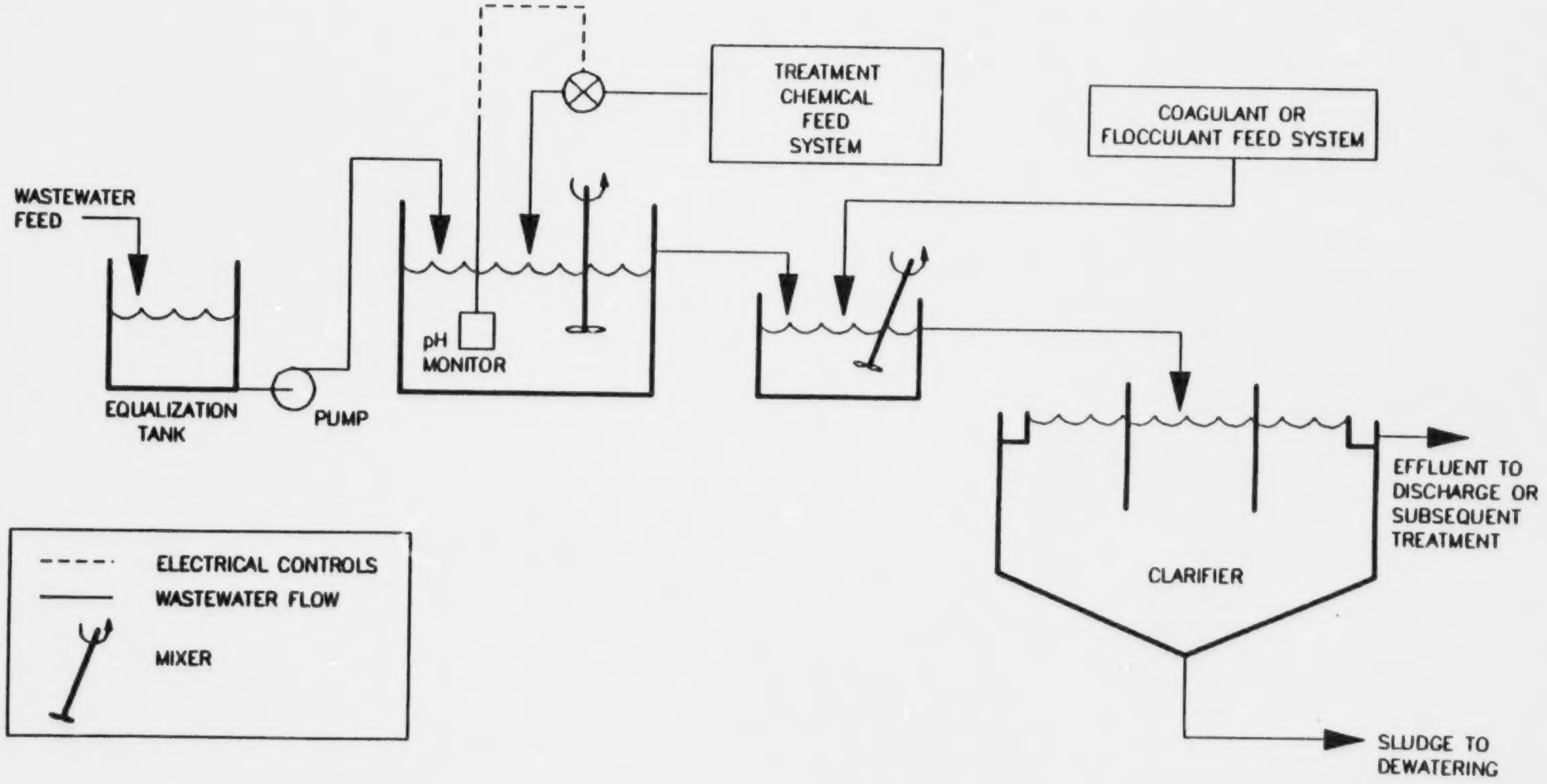

WASTEWATER FEED
EQUALIZATION TANK
PUMP
pH MONITOR
TREATMENT CHEMICAL FEED SYSTEM
COAGULANT OR FLOCCULANT FEED SYSTEM
CLARIFIER
EFFLUENT TO DISCHARGE OR SUBSEQUENT TREATMENT
SLUDGE TO DEWATERING
ELECTRICAL CONTROLS
WASTEWATER FLOW
MIXER

FIGURE 3–5 CONTINUOUS CHEMICAL PRECIPITATION

For a batch system, chemical precipitation requires only a feed system for the treatment chemicals and a second tank where the waste can be treated and allowed to settle. When lime is used, it is usually added to the reaction tank in a slurry form. In a batch system, the supernate is generally analyzed before discharge, thereby minimizing the need for instrumentation.

In a continuous system, additional tanks are necessary, along with the instrumentation to ensure that the system is operating properly. In this system, the first tank that the wastewater enters is referred to as an equalization tank. This is where the waste is mixed to provide more uniformity, thus minimizing wide swings in the type and concentration of constituents being sent to the reaction tank. It is important to reduce the variability of the waste sent to the reaction tank because control systems inherently are limited with regard to the maximum fluctuations that can be managed.

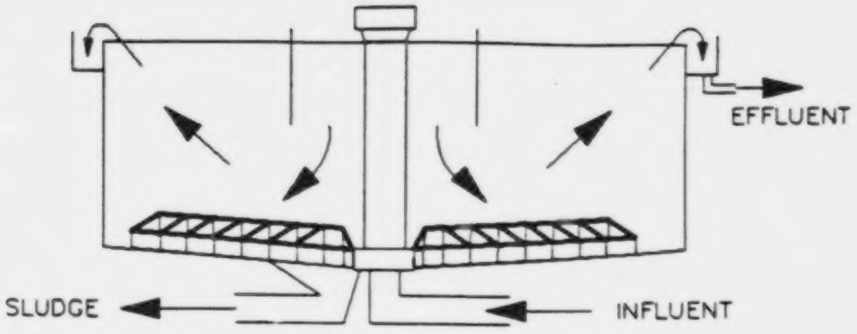
Following equalization, the waste is pumped to a reaction tank where treatment chemicals are added; this is done automatically by using instrumentation that senses the pH of the system and then pneumatically adjusts the position of the treatment chemical feed valve so that the design pH value is achieved. Both the complexity and the effectiveness of the automatic control system will vary depending on the variation in the waste and the pH range that is needed to properly treat the waste.

An important aspect of the reaction tank design is that it be well-mixed so that the waste and the treatment chemicals are both dispersed throughout the tank to ensure commingling of the reactant and the treatment chemicals. In addition, effective dispersion of the treatment chemicals throughout the tank is necessary to properly monitor and thereby control the amount of treatment chemicals added.

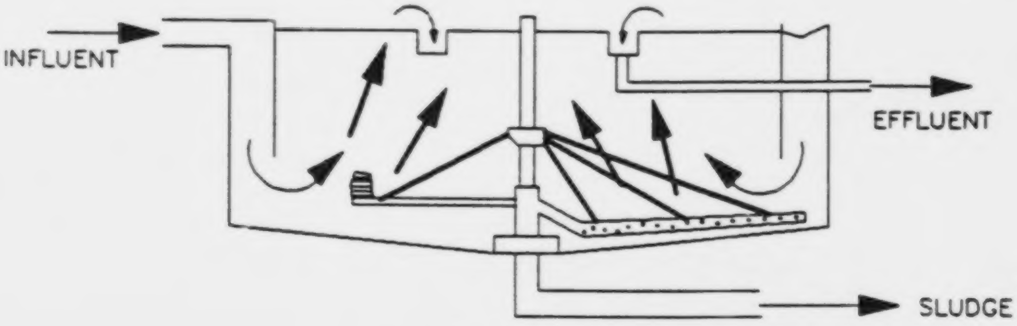
After the waste is reacted with the treatment chemical, it flows to a quiescent tank where the precipitate is allowed to settle and to be subsequently removed. Settling can be chemically assisted through the use of flocculating compounds. Flocculants increase the particle size and density of the precipitated solids, both of which increase the rate of settling. The particular flocculating agent that will best improve settling characteristics will vary depending on the particular waste; selection of the flocculating agent is generally accomplished by performing laboratory bench tests. Settling can be conducted in a large tank by relying solely on gravity or it can be mechanically assisted through the use of a circular clarifier or an inclined separator. Schematics of the latter two separators are shown in Figures 3-6 and 3-7.

Filtration can be used for further removal of precipitated residuals both in cases where the settling system is underdesigned and in cases where the particles are difficult to settle. Polishing filtration is discussed in a separate technology section.

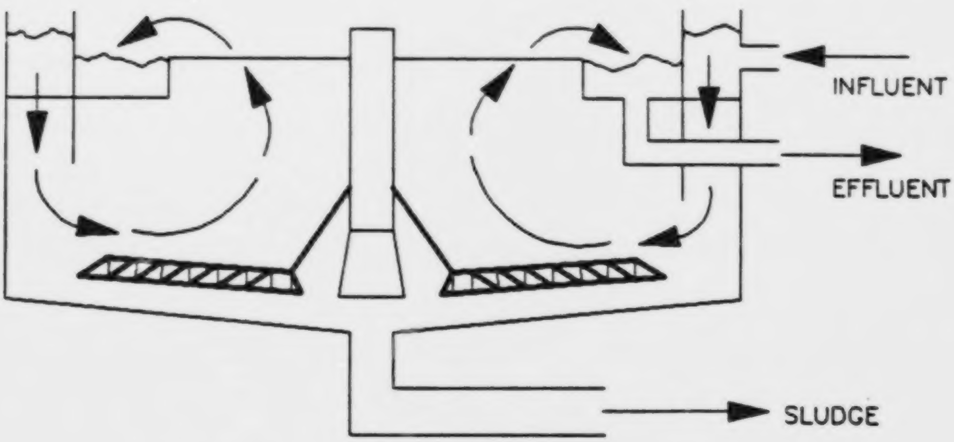
(4) Waste characteristics affecting performance. In determining whether chemical precipitation is likely to achieve the same level of performance on an untested waste as on a previously tested waste, we will examine the following waste characteristics: (1) the concentration and


EFFLUENT
SLUDGE
INFLUENT

CENTER FEED CLARIFIER WITH SCRAPER SLUDGE REMOVAL SYSTEM


INFLUENT
EFFLUENT
SLUDGE

RIM FEED – CENTER TAKEOFF CLARIFIER WITH
HYDRAULIC SUCTION SLUDGE REMOVAL SYSTEM


INFLUENT
EFFLUENT
SLUDGE

RIM FEED – RIM TAKEOFF CLARIFIER

FIGURE 3–6 CIRCULAR CLARIFIERS

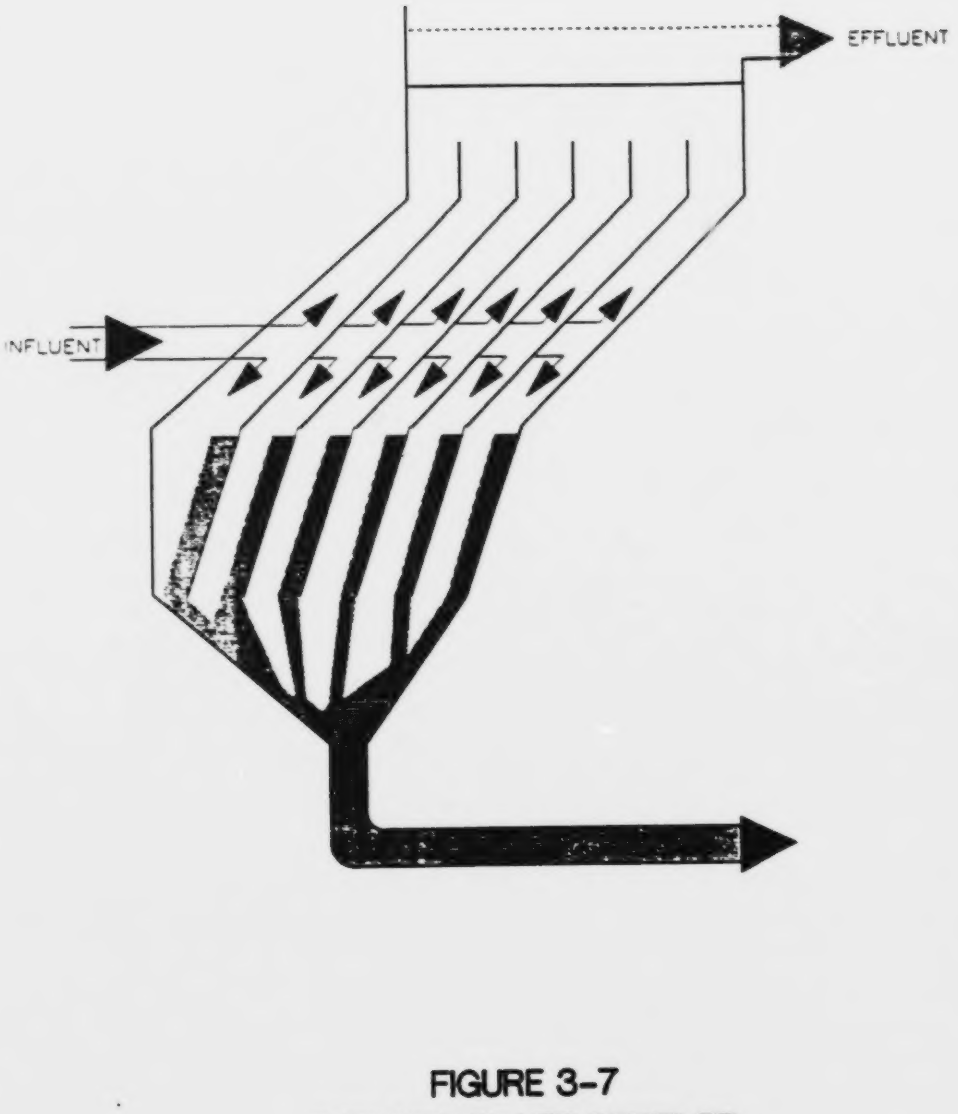

EFFLUENT
INFLUENT

FIGURE 3-7
INCLINED PLATE SETTLER

type of the metal(s) in the waste, (2) the concentration of total suspended solids (TSS), (3) the concentration of total dissolved solids (TDS), (4) whether the metal exists in the wastewater as a complex, and (5) the oil and grease content. These parameters affect the chemical reaction of the metal compound, the solubility of the metal precipitate, or the ability of the precipitated compound to settle.

(a) Concentration and type of metals. For most metals, there is a specific pH at which the metal hydroxide is least soluble. As a result, when a waste contains a mixture of many metals, it is not possible to operate a treatment system at a single pH that is optimal for the removal of all metals. The extent to which this affects treatment depends on the particular metals to be removed and their concentrations. One alternative is to operate multiple precipitations, with intermediate settling, when the optimum pH occurs at markedly different levels for the metals present. The individual metals and their concentrations can be measured using EPA Method 6010.

(b) Concentration and type of total suspended solids (TSS). Certain suspended solid compounds are difficult to settle because of either their particle size or their shape. Accordingly, EPA will evaluate this characteristic in assessing transfer of treatment performance. Total suspended solids can be measured by EPA Wastewater Test Method 160.2. The amounts of total suspended solids present in the K101 and K102 wastewaters are 289 to 1,620 mg/l and 1,980 to 6,140 mg/l, respectively.

(c) Concentration of total dissolved solids (TDS). Available information shows that total dissolved solids can inhibit settling. The literature states that poor flocculation is a consequence of high TDS and shows that higher concentrations of total suspended solids are found in treated residuals. Poor flocculation can adversely affect the degree to which precipitated particles are removed. Total dissolved solids can be measured by EPA Wastewater Test Method 160.1. The amount of total dissolved solids present in the K101 and K102 wastewaters are 8,460 to 23,600 mg/l and 1,930 to 2,620 mg/l, respectively.

(d) Complexed metals. Metal complexes consist of a metal ion surrounded by a group of other inorganic or organic ions or molecules (often called ligands). In the complexed form, the metals have a greater solubility and therefore may not be removed as effectively from solution by chemical precipitation. EPA does not have an analytical method to determine the amount of complexed metals in the waste. The Agency believes that the best measure of complexed metals is to analyze for some common complexing compounds (or complexing agents) generally found in wastewater for which analytical methods are available. These complexing agents include ammonia, cyanide, and EDTA. The analytical method for cyanide is EPA Method 9010. The method for EDTA is ASTM Method D3113. Ammonia can be analyzed using EPA Wastewater Test Method 350.

(e) Oil and grease content. The oil and grease content of a particular waste directly inhibits the settling of the precipitate. Suspended oil droplets float in water and tend to suspend particles such as chemical precipitates that would otherwise settle out of the solution. Even with the use of coagulants or flocculants, the separation of the precipitate is less effective. Oil and grease content can be measured by EPA Method 9071.

(5) Design and operating parameters. The parameters that EPA will evaluate when determining whether a chemical precipitation system is well designed are: (1) design value for treated metal concentrations, as well as other characteristics of the waste used for design purposes (e.g., total suspended solids), (2) pH, (3) residence time, (4) choice of treatment chemical, (5) choice of coagulant/flocculant, and (6) mixing. Below is an explanation of why EPA believes these parameters are important to a design analysis as well as an explanation of why other design criteria are not included in EPA's analysis.

(a) Treated and untreated design concentrations. EPA pays close attention to the treated concentration the system is designed to achieve when determining whether to sample a particular facility. Since the system will seldom outperform its design, EPA must evaluate whether the design is consistent with best demonstrated practice.

The untreated concentrations that the system is designed to treat are important in evaluating any treatment system. Operation of a chemical precipitation treatment system with untreated waste concentrations in excess of design values can easily result in poor performance.

(b) pH. The pH is important because it can indicate whether sufficient treatment chemical (e.g., lime) has been added to convert the metal constituents in the untreated waste to forms that will precipitate. The pH also affects the solubility of metal hydroxides and sulfides and therefore directly impacts the effectiveness of removal. In practice, the design pH is determined by empirical bench testing, often referred to as "jar" testing. The temperature at which the "jar" testing is conducted is important in that it also affects the solubility of the metal precipitates. Operation of a treatment system at temperatures above the design temperature can result in poor performance. In assessing the operation of a chemical precipitation system, EPA prefers continuous data on the pH and periodic temperature conditions throughout the treatment period.

(c) Residence time. Residence time is important because it impacts the completeness of the chemical reaction to form the metal precipitate and, to a greater extent, the amount of precipitate that settles out of solution. In practice, it is determined by "jar" testing. For continuous systems, EPA will monitor the feed rate to ensure that the system is operated at design conditions. For batch systems, EPA will want information on the design parameter used to determine sufficient settling time (e.g., total suspended solids).

(d) Choice of treatment chemical. A choice must be made as to what type of precipitating agent (i.e., treatment chemical) will be used. The factor that most affects this choice is the type of metal constituents to be treated. Other design parameters, such as pH, residence time, and choice of coagulant/flocculant agents, are based on the selection of the treatment chemical.

(e) Choice of coagulant/flocculant. This parameter is important because these compounds improve the settling rate of the precipitated metals and enable smaller systems (i.e., lower retention time) to achieve the same degree of settling as much larger systems. In practice, the choice of the best agent and the required amount is determined by "jar" testing.

(f) Mixing. The degree of mixing is a complex assessment that includes, among other things, the energy supplied, the time the material is mixed, and the related turbulence effects of the specific size and shape of the tank. EPA will, however, consider whether mixing is provided and whether the type of mixing device is one that could be expected to achieve uniform mixing. For example, EPA may not use data from a chemical precipitation treatment system where an air hose was placed in a large tank to achieve mixing.

4. PERFORMANCE DATA BASE

4.1 Introduction

This section discusses all available performance data that EPA has amassed on the demonstrated technologies discussed in Section 3. Performance data include the untreated and treated waste concentrations for a given constituent, the operating values that existed at the time the waste was being treated, the design values for the treatment technology, and data on waste characteristics that affect treatment performance. EPA has provided all such data to the extent that they are available.

EPA's use of these data in determining the technology that represents BDAT and in the development of treatment standards is discussed in Sections 5 and 7, respectively. For K101 and K102, EPA has performance data on rotary kiln incineration, stabilization of kiln ash and precipitated metals, and chemical precipitation of the scrubber waters.

4.2 Incineration Performance Data

Performance data collected by EPA for rotary kiln incineration are provided in Tables 4-1 to 4-11. These tables present the analytical data for K101 and K102 collected during the Agency's sampling visit. The untreated K101 and K102 wastes, the treated K101 and K102 wastes (kiln ash), and the scrubber wastewater generated were analyzed for BDAT list volatile and semivolatile organic compounds and other parameters that affect incinerator performance.

TABLE 4-1 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #1 [a]

Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (SZ7-101) (mg/kg)	Scrubber Wastewater (SZ9-101) (mg/l)
BDAT LIST		
Volatile Organics		
222 Acetone	<50	<0.010
43 Toluene	<25	<0.005
Semivolatile Organics		
70 Bis(2-ethylhexyl)Phthalate	36,000	0.020
NON-BDAT LIST		
* 2-Nitroaniline	191,000	<0.050
Total Solids	748,000	10,400
Total Suspended Solids	NA	1,620
Total Dissolved Solids	NA	8,460
Total Organic Carbon	407,400	67.3**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1850 - 1960
Kiln exhaust temperature (deg. F), T2	1600-2000	1855 - 1961
Kiln pressure (in. H_2O), KV	< -0.10	(-0.06) - (-0.12)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.96 - 1.64
Natural gas pressure to kiln (psig), PGK	25	24.5 - 25
Afterburner temperature (deg. F), T3	2000	1984 - 2010
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.880
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	445 - 595
Feed rate of K102 to kiln (lbs/hr), FW	500	204
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.94 - 1.98
Pressure drop across Stage 1 (in. H_2O), P1	20-25	27
Pressure drop across Stage 2 (in. H_2O), P2	20-25	21.5
Total pressure drop across scrubber unit (in. H_2O), PT	>30	38.5 - 39.5
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	180 - 182
Stage 2 nozzle temperature (deg. F), T7	Not controlled	175 - 180
Cyclone outlet temperature (deg. F), T8	Not controlled	175 - 180
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

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a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-3.

* - Not on BDAT List

** - This is an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-2 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #2 [a]

	Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (S27-102) (mg/kg)	Scrubber Wastewater (S29-102) (mg/l)
	BDAT LIST		
	Volatile Organics		
222	Acetone	<50	<0.010
43	Toluene	<25	<0.005
	Semivolatile Organics		
70	Bis(2-ethylhexyl)Phthalate	<38,000	0.013
	NON-BDAT LIST		
*	2-Nitroaniline	<188,000	<0.050
	Total Solids	793,000	32,000
	Total Suspended Solids	NA	914
	Total Dissolved Solids	NA	23,600
	Total Organic Carbon	401,100	89.6**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1710 - 1940
Kiln exhaust temperature (deg. F), T2	1600-2000	1735 - 1914
Kiln pressure (in. H_2O), KV	< -0.10	(-0.06) - (-0.20)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.400 - 0.640
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1991 - 2019
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.640 - 0.920
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	474 - 543
Feed rate of K102 to kiln (lbs/hr), FW	500	196
Recirculation pump discharge pressure (psig), P1	80	75 - 80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.98 - 2.10
Pressure drop across Stage 1 (in. H_2O), P1	20-25	27 - 28
Pressure drop across Stage 2 (in. H_2O), P2	20-25	20 - 21
Total pressure drop across scrubber unit (in. H_2O), PT	>30	38.5
Scrubber inlet temperature (deg. F), T5	Not controlled	205 - 210
Stage 1 nozzle temperature (deg. F), T6	Not controlled	184 - 188
Stage 2 nozzle temperature (deg. F), T7	Not controlled	174 - 175
Cyclone outlet temperature (deg. F), T8	Not controlled	175
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	11.25 - 12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

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a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-4.

* - Not on BDAT List

** - This is an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-3 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #3 [a]

Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (SZ7-103) (mg/kg)	Scrubber Wastewater (SZ9-103) (mg/l)
BDAT LIST		
Volatile Organics		
222 Acetone	<50	<0.010
43 Toluene	42	<0.005
Semivolatile Organics		
70 Bis(2-ethylhexyl)Phthalate	<34,000	0.011
NON-BDAT LIST		
* 2-Nitroaniline	<172,000	<0.050
Total Solids	804,000	18,500
Total Suspended Solids	NA	289
Total Dissolved Solids	NA	17,700
Total Organic Carbon	281,200	30.4**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1625 - 1940
Kiln exhaust temperature (deg. F), T2	1600-2000	1576 - 1880
Kiln pressure (in. H_2O), KV	< -0.10	(-0.06) - (-0.10)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.400
Natural gas pressure to kiln (psig), PGK	25	24.5
Afterburner temperature (deg. F), T3	2000	1940 - 1991
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.92 - 0.96
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	458 - 513
Feed rate of K102 to kiln (lbs/hr), FW	500	192
Recirculation pump discharge pressure (psig), P1	80	75 - 80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	2.10 - 2.16
Pressure drop across Stage 1 (in. H_2O), P1	20-25	27
Pressure drop across Stage 2 (in. H_2O), P2	20-25	20
Total pressure drop across scrubber unit (in. H_2O), PT	>30	38.5
Scrubber inlet temperature (deg. F), T5	Not controlled	205
Stage 1 nozzle temperature (deg. F), T6	Not controlled	180 - 188
Stage 2 nozzle temperature (deg. F), T7	Not controlled	175
Cyclone outlet temperature (deg. F), T8	Not controlled	170 -175
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-5.
* - Not on BDAT List
** - This is an average of two results for total organic carbon analysis on same sample.
NA - Not analyzed.

TABLE 4-4 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #4 [a]

	Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (SZ7-104) (mg/kg)	Scrubber Wastewater (SZ9-104) (mg/l)
	BDAT LIST		
	Volatile Organics		
222	Acetone	81	<0.010
43	Toluene	<25	<0.005
	Semivolatile Organics		
70	Bis(2-ethylhexyl)Phthalate	<38,000	0.012
	NON-BDAT LIST		
*	2-Nitroaniline	<190,000	<0.050
	Total Solids	604,000	22,600
	Total Suspended Solids	NA	373
	Total Dissolved Solids	NA	21,100
	Total Organic Carbon	254,900	38.0**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1700
Kiln exhaust temperature (deg. F), T2	1600-2000	1383 - 1631
Kiln pressure (in. H_2O), KV	< -0.10	0 - (-0.10)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.40 - 2.00
Natural gas pressure to kiln (psig), PGK	25	24.5
Afterburner temperature (deg. F), T3	2000	1868 - 1891
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.96
Natural gas pressure to afterburner (psig), PGA	25	24 - 24.5
Quench tower temperature (deg. F), T4	Not controlled	467 - 486
Feed rate of K102 to kiln (lbs/hr), FW	500	129
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	2.0 - 2.25
Pressure drop across Stage 1 (in. H_2O), P1	20-25	27
Pressure drop across Stage 2 (in. H_2O), P2	20-25	20
Total pressure drop across scrubber unit (in. H_2O), PT	>30	38.5 - 40.6
Scrubber inlet temperature (deg. F), T5	Not controlled	205
Stage 1 nozzle temperature (deg. F), T6	Not controlled	178
Stage 2 nozzle temperature (deg. F), T7	Not controlled	175
Cyclone outlet temperature (deg. F), T8	Not controlled	170 - 172
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-6.

* - Not on BDAT List

** - This is an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-5 ANALYTICAL RESULTS FOR TREATMENT OF K101 BY INCINERATION - Sample Sets 2A, 2B, and 1 [a]

	Sample Location (EPA Sample Number)	Treated Waste (Kiln Ash) (2A) TOTAL (mg/kg)	Treated Waste (Kiln Ash) (2B) TOTAL (mg/kg)	Treated Waste (Kiln Ash) (1) TOTAL (mg/kg)
BDAT List				
	Volatile Organics			
222	Acetone	0.010	<0.010	<0.010
43	Toluene	<0.005	<0.005	<0.005
	Semivolatile Organics			
70	Bis(2-ethylhexyl)Phthlate	<0.420	<0.420	<0.420
NON -BDAT List				
*	2-Nitroaniline	<2	<2	<2
	Total Solids (%)	94.5	94.8	96.2
	Total Suspended Solids	NA	NA	NA
	Total Dissolved Solids	NA	NA	NA
	Total Organic Carbon	267**	795**	2,130**

[a] - Obtained from the Onsite Engineering Report, John Zink Company, Tulsa, Oklahoma for K101, Table 5-7.

* - Constituent is not on the BDAT list.

** - This is an average of four results for Total Organic Carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-6 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #1 [a]

	Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (SZ4-101) (mg/kg)	Treated Waste (Kiln Ash) (SZ5-101) Total (mg/kg)	Scrubber Wastewater (SZ6-101) (mg/l)
BDAT LIST				
	Volatile Organics			
43	Toluene	9.4	<1.5	<0.005
215-217	Total Xylenes	<1.5	<1.5	<0.005
	Semivolatile Organics			
70	Bis(2-ethylhexyl)Phthalate	<182	<1.0	0.016
142	Phenol	<182	<1.0	0.017
NON-BDAT LIST				
*	2-Nitrophenol	370	<1.0	<0.010
	Total Solids	337,000	732,500**	6200
	Total Suspended Solids	NA	NA	1,980
	Total Dissolved Solids	NA	NA	1,930
	Total Organic Carbon	173,200	22,400***	17.1***

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	2000
Kiln exhaust temperature (deg. F), T2	1600-2000	1889-1892
Kiln pressure (in. H_2O), KV	< -0.10	(-0.01)-(-0.02)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.92
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1928-1934
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.88-1.04
Natural gas pressure to afterburner (psig), PGA	25	20-27.5
Quench tower temperature (deg. F), T4	Not controlled	486-496
Feed rate of K102 to kiln (lbs/hr), FW	500	565
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.62-1.68
Pressure drop across Stage 1 (in. H_2O), P1	20-25	21.5-27.0
Pressure drop across Stage 2 (in. H_2O), P2	20-25	20.0-21.0
Total pressure drop across scrubber unit (in. H_2O), PT	>30	30.5-31.0
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	170-172
Stage 2 nozzle temperature (deg. F), T7	Not controlled	180-185
Cyclone outlet temperature (deg. F), T8	Not controlled	180
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	10.1-10.5
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0-6.5
Steam pressure (psig), PS	160-170	180-185
Steam temperature (deg. F), TS	370-380	375

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a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-3.

* - Not on BDAT List

** - This is an average of two results for total solids analysis on same sample.

*** - This is an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-7 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #2 [a]

	Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (SZ4-102) (mg/kg)	Treated Waste (Kiln Ash) (SZ5-102) Total (mg/kg)	Scrubber Wastewater (SZ6-102) (mg/l)
BDAT LIST				
	Volatile Organics			
43	Toluene	5.4	<1.5	<0.005
215-217	Total Xylenes	<1.5	<1.5	<0.005
	Semivolatile Organics			
70	Bis(2-ethylhexyl)Phthalate	<19.4	<1.0	<0.010
142	Phenol	<19.4	<1.0	0.019T
NON-BDAT LIST				
*	2-Nitrophenol	220	<1.0	<0.010
	Total Solids	356,000	706,000**	5,130
	Total Suspended Solids	NA	NA	2,910
	Total Dissolved Solids	NA	NA	2,610
	Total Organic Carbon	166,000	24,200***	22.9***

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1860-1950
Kiln exhaust temperature (deg. F), T2	1600-2000	1864-1924
Kiln pressure (in. H_2O), KV	< -0.10	-0.05
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.04-1.20
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1949
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.92-0.96
Natural gas pressure to afterburner (psig), PGA	25	20
Quench tower temperature (deg. F), T4	Not controlled	486-509
Feed rate of K102 to kiln (lbs/hr), FW	500	565
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.54-1.64
Pressure drop across Stage 1 (in. H_2O), P1	20-25	20.5-21.0
Pressure drop across Stage 2 (in. H_2O), P2	20-25	19.5-21.0
Total pressure drop across scrubber unit (in. H_2O), PT	>30	30.0-30.5
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	176-178
Stage 2 nozzle temperature (deg. F), T7	Not controlled	180-185
Cyclone outlet temperature (deg. F), T8	Not controlled	180-182
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	9.75
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.5
Steam pressure (psig), PS	160-170	165-167
Steam temperature (deg. F), TS	370-380	375

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-4.

* - Constituent has not yet been assigned a BDAT number.

** - This is an average of two results for total solids analysis on same sample.

*** - This is an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

T - This value is under investigation by laboratory to confirm compound's presence.

TABLE 4-8 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #5 [a]

	Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (SZ4-103) (mg/kg)	Treated Waste (Kiln Ash) (SZ5-103) Total (mg/kg)	Scrubber Wastewater (SZ6-103) (mg/l)
BDAT LIST				
	Volatile Organics			
43	Toluene	5.7	<1.5	<0.005
215-217	Total Xylenes	<1.5	<1.5	<0.005
	Semivolatile Organics			
70	Bis(2-ethylhexyl)Phthalate	<19.4	<1.0	0.022
142	Phenol	<19.4	<1.0	<0.010
NON-BDAT LIST				
*	2-Nitrophenol	230	<1.0	<0.010
	Total Solids	355,000	601,500**	5,130
	Total Suspended Solids	NA	NA	4,440
	Total Dissolved Solids	NA	NA	2,550
	Total Organic Carbon	167,800	36,700***	23.9***

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1800-1850
Kiln exhaust temperature (deg. F), T2	1600-2000	1850-1879
Kiln pressure (in. H_2O), KV	< -0.10	0.0-0.15*
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.00-1.04
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1925-1928
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.80
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	480
Feed rate of K102 to kiln (lbs/hr), FW	500	515
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.46-1.56
Pressure drop across Stage 1 (in. H_2O), P1	20-25	21.5-26.0
Pressure drop across Stage 2 (in. H_2O), P2	20-25	20.5-21.0
Total pressure drop across scrubber unit (in. H_2O), PT	>30	30.5-31.0
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	178
Stage 2 nozzle temperature (deg. F), T7	Not controlled	185
Cyclone outlet temperature (deg. F), T8	Not controlled	182
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	10.5
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.5-6.6
Steam pressure (psig), PS	160-170	170-180
Steam temperature (deg. F), TS	370-380	375

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a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-5.

* - Not on BDAT List

** - This is an average of two results for total solids analysis on same sample.

*** - This is an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-9 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #4 [a]

	Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (SZ4-104) (mg/kg)	Treated Waste (Kiln Ash) (SZ5-104) Total (mg/kg)	Scrubber Wastewater (SZ6-104) (mg/l)
	BDAT LIST			
	Volatile Organics			
43	Toluene	6.1	<1.5	<0.005
215-217	Total Xylenes	<1.5	<1.5	<0.005
	Semivolatile Organics			
70	Bis(2-ethylhexyl)Phthalate	<194	<1.0	0.031
142	Phenol	<194	<1.0	0.023
	NON-BDAT LIST			
*	2-Nitrophenol	480	<1.0	<0.010
	Total Solids	333,000	400,500**	8,260
	Total Suspended Solids	NA	NA	6,290
	Total Dissolved Solids	NA	NA	2,620
	Total Organic Carbon	163,100	422,000***	25.9***

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1750-1775
Kiln exhaust temperature (deg. F), T2	1600-2000	1817-1827
Kiln pressure (in. H_2O), KV	< -0.10	(-0.05)-(-0.10)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.04-1.12
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1931-1953
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.76
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	482-490
Feed rate of K102 to kiln (lbs/hr), FW	500	414
Recirculation pump discharge pressure (psig), P1	80	75-80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.52-1.54
Pressure drop across Stage 1 (in. H_2O), P1	20-25	21.0-21.5
Pressure drop across Stage 2 (in. H_2O), P2	20-25	21.0
Total pressure drop across scrubber unit (in. H_2O), PT	>30	31.5-35.5
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	176
Stage 2 nozzle temperature (deg. F), T7	Not controlled	182-185
Cyclone outlet temperature (deg. F), T8	Not controlled	180-183
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	10.5
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.6
Steam pressure (psig), PS	160-170	162-195
Steam temperature (deg. F), TS	370-380	372-380

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a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-6.

* - Not on BDAT List

** - This is an average of two results for total solids analysis on same sample.

*** - This is an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-10 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #5 [a]

	Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (SZ4-105) (mg/kg)	Treated Waste (Kiln Ash) (SZ5-105) Total (mg/kg)	Scrubber Wastewater (SZ6-105) (mg/l)
BDAT LIST				
	Volatile Organics			
43	Toluene	23	NO SAMPLES TAKEN	<0.005
215-217	Total Xylenes	4.5		<0.005
	Semivolatile Organics			
70	Bis(2-ethylhexyl)Phthalate	<194		0.021
142	Phenol	<194		0.015
NON-BDAT LIST				
*	2-Nitrophenol	740		<0.010
	Total Solids	393,000		8,920
	Total Suspended Solids	NA		6,210
	Total Dissolved Solids	NA		2,530
	Total Organic Carbon	214,700		30.3**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1780
Kiln exhaust temperature (deg. F), T2	1600-2000	1837-1848
Kiln pressure (in. H_2O), KV	< -0.10	-0.08
Kiln rotational speed (rpm), RS	0.25	0.25-0.29
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.12
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1928-1930
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.76
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	491-518
Feed rate of K102 to kiln (lbs/hr), FW	500	414
Recirculation pump discharge pressure (psig), P1	80	75-77
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.50
Pressure drop across Stage 1 (in. H_2O), P1	20-25	21.5
Pressure drop across Stage 2 (in. H_2O), P2	20-25	20.5
Total pressure drop across scrubber unit (in. H_2O), PT	>30	30.5-31.0
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	176-178
Stage 2 nozzle temperature (deg. F), T7	Not controlled	185
Cyclone outlet temperature (deg. F), T8	Not controlled	182
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	10.1
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.6
Steam pressure (psig), PS	160-170	165
Steam temperature (deg. F), TS	370-380	375

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-7.

* - Not on BDAT List

** - This is an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-11 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #6 [a]

	Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (S24-106) (mg/kg)	Treated Waste (Kiln Ash) (S25-106) Total (mg/kg)	Scrubber Wastewater (S26-106) (mg/l)
BDAT LIST				
	Volatile Organics		NO SAMPLES TAKEN	
43	Toluene	26		<0.005
215-217	Total Xylenes	5.3		<0.005
	Semivolatile Organics			
70	Bis(2-ethylhexyl)Phthalate	<184		0.012
142	Phenol	<184		0.017
NON-BDAT LIST				
*	2-Nitrophenol	870		<0.010
	Total Solids	395,000		9,160
	Total Suspended Solids	NA		6,410
	Total Dissolved Solids	NA		2,370
	Total Organic Carbon	216,500		35.9**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1740
Kiln exhaust temperature (deg. F), T2	1600-2000	1810-1828
Kiln pressure (in. H_2O), KV	< -0.10	(-0.09)-(-0.12)
Kiln rotational speed (rpm), RS	0.25	0.29
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.08-1.12
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1971-1976
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.76
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	526-560
Feed rate of K102 to kiln (lbs/hr), FW	500	389
Recirculation pump discharge pressure (psig), P1	80	74-77
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H_2O), PV	>0	1.50-1.52
Pressure drop across Stage 1 (in. H_2O), P1	20-25	21.5-22.0
Pressure drop across Stage 2 (in. H_2O), P2	20-25	20.5-21.0
Total pressure drop across scrubber unit (in. H_2O), PT	>30	30.5-31.5
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	176-182
Stage 2 nozzle temperature (deg. F), T7	Not controlled	185
Cyclone outlet temperature (deg. F), T8	Not controlled	180-182
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	9.9-10.5
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.3-6.6
Steam pressure (psig), PS	160-170	160-190
Steam temperature (deg. F), TS	370-380	370-380

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a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-8.

* - Not on BDAT List

** - This is an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

4.3 Stabilization Performance Data

Performance data for the stabilization of K101 and K102 kiln ash and precipitated metals from the scrubber waters were not collected by EPA. Therefore, performance data will be transferred from the stabilization of waste code F006, which is similar based on waste characteristics affecting performance. Tables 4-12 and 4-13 present analytical data for K101 and K102 kiln ash. The kiln ash was analyzed for BDAT list metals and other parameters that affect the stabilization process. The analytical results for the treatment of F006 by stabilization are shown in Tables 4-14 and 4-15. Table 4-16 presents the composition data for the cement kiln dust used in the stabilization process.

4.4 Chemical Precipitation Data

Performance data for chemical precipitation of K101 and K102 scrubber waters were not collected by EPA. Therefore, performance data will be transferred from the data obtained for the chemical precipitation of D004 waste. Tables 4-17 and 4-18 present analytical data for K101 and K102 scrubber water. The scrubber water was analyzed for BDAT list metals and other parameters that affect the precipitation process. The analytical results and operating data for the treatment of D004 by precipitation are shown in Tables 4-19 to 4-23.

TABLE 4-12 ANALYTICAL RESULTS FOR UNTREATED K101 KILN ASH - Sample Sets 2A, 2B, and 1 [a]

	Sample Location (EPA Sample Number)	Untreated Waste (Kiln Ash) (2A)		Untreated Waste (Kiln Ash) (2B)		Untreated Waste (Kiln Ash) (1)	
		TOTAL (mg/kg)	TCLP (mg/l)	TOTAL (mg/kg)	TCLP (mg/l)	TOTAL (mg/kg)	TCLP (mg/l)
BDAT LISTED							
	Metals						
154	Antimony	104	0.377	88	0.462	87	0.204
155	Arsenic	360	0.656	244	0.730	355	0.376
156	Barium	294	0.485	288	0.537	289	0.594
157	Beryllium	0.56	<0.001	0.54	<0.001	0.52	0.0011
158	Cadmium	<0.50	0.0088	<0.50	0.0094	<0.50	0.0051
159	Chromium	232	0.143	206	0.127	261	0.232
160	Copper	554	1.30	540	1.060	417	1.030
161	Lead	6.3	0.009	7.2	<0.0005	8.2	<0.005
162	Mercury	<0.1	<0.0002	<0.1	<0.0002	<0.1	<0.0002
163	Nickel	297	0.450	265	0.379	262	0.366
164	Selenium	<0.5	<0.005	<0.5	<0.010	<0.5	<0.025
165	Silver	0.86	<0.007	<0.70	<0.007	<0.70	<0.007
166	Thallium	<1.0	<0.010	<1.0	<0.010	<1.0	<0.010
167	Vanadium	31	0.014	30	0.020	27	0.025
168	Zinc	173	0.323	166	0.391	132	0.293
	Inorganic						
171	Sulfide	13.6	NA	16.9	NA	20.5	NA
NON-BDAT LISTED							
	Chlorides	8.7	NA	11.1	NA	11.0	NA
	Sulfate	148	NA	172	NA	193	NA
	Total Organic Carbon	267**	NA	795**	NA	2,130**	NA

a - Obtained from the Onsite Engineering Report, John Zink Company, Tulsa, Oklahoma for K101, Table 5-7.

** - This is an average of four results for Total Organic Carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-13 ANALYTICAL RESULTS FOR UNTREATED K102 KILN ASH - Sample Sets 1, 2, 3, and 4 [a]

	Untreated Waste (Kiln Ash)							
	Sample Set 1		Sample Set 2		Sample Set 3		Sample Set 4	
	Total (mg/kg)	TCLP (mg/l)	Total (mg/kg)	TCLP (mg/l)	Total (mg/kg)	TCLP (mg/l)	Total (mg/kg)	TCLP (mg/l)
BDAT LISTED								
Metals								
154 Antimony	369	8.02	349	8.140	1990	16.3	203	9.73
155 Arsenic	633	8.69	844	14.3	1060	17.1	1,080	38.3
156 Barium	39	0.206	32	0.218	30	0.273	15	0.241
157 Beryllium	<0.1	<0.001	<0.1	<0.001	<0.1	<0.001	<0.1	<0.001
158 Cadmium	1.3	0.020	1.4	0.029	4.2	0.059	<0.5	0.084
159 Chromium	32	0.019	42	0.0052	12	<0.007	15	0.286
160 Copper	42	0.343	46	0.103	36	0.048	8.7	0.0082
161 Lead	11	<0.005	10.5	<0.005	<0.5	0.0056	1.7	<0.005
162 Mercury	0.12	<0.0002	<0.1	<0.0002	<0.1	<0.0002	<0.1	0.00021
163 Nickel	56	0.370	76	0.541	35	0.383	9.1	0.428
164 Selenium	8.0	<0.050	6.7	0.054	7.6	0.036	13	<0.005
165 Silver	<0.7	<0.007	<0.7	<0.007	<0.7	<0.007	<0.7	<0.007
166 Thallium	<5.0	<0.500	<1.0	<0.200	<1.0	<0.200	<1.0	<0.100
167 Vanadium	4.3	<0.004	3.4	<0.004	2.5	<0.004	0.73	<0.004
168 Zinc	24	0.285	21	0.526	12	0.577	2.3	0.214
Inorganics								
171 Sulfide	7.0	NA	6.4	NA	7.9	NA	8.7	NA
NON-BDAT LISTED								
Chlorides	83.9	NA	89.3	NA	103	NA	71.5	NA
Sulfate	12.0	NA	21.4	NA	18.8	NA	55.9	NA
Total Organic Carbon	22,400***	NA	24,200***	NA	36,700***	NA	422,000***	NA

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-3 through 5-6.

*** - This an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 4-14 ANALYTICAL RESULTS FOR UNTREATED F006 WASTE

	Total Concentration in Raw Waste Sample - F006 (ppm)								
	#1	#2	#3	#4	#5	#6	#7	#8	#9
BDAT CONSTITUENT									
Barium	--	--	85.5	--	14.3	--	--	15.3	19.2
Cadmium	--	31.3	67.3	1.31	720	7.28	5.39	5.81	--
Chromium	--	755	716	--	12,200	3,100	42,900	--	--
Copper	--	7,030	--	1,510	160	1,220	10,600	17,600	27,400
Lead	--	409	257	88.5	52	113	156	1.69	24,500
Nickel	435	989	259	374	701	19,400	13,000	23,700	5,730
Silver	--	6.62	38.9	9.05	5.28	4.08	12.5	8.11	--
Zinc	1,560	4,020	631	90,200	35,900	27,800	120	15,700	322

1 - Wastewater treatment sludge cake - no free liquid.
2 - Site closure excavation mud at auto part manufacturer. The waste sample is a mixture of F006 and F007.
3 - Waste treatment sludge from aircraft overhaul facility. The waste sample is a mixture of F006, D006, D007, and D008.
4 - Zinc electroplating sludge.
5 - Filter cake from electroplating wastewater treatment.
6 - Sludge from treatment of Cr, Cu, Ni, and Zn plating.
7 - Wastewater treatment sludge from plating on plastics.
8 - Wastewater treatment sludge.
9 - To be provided

Source: CWM Technical Note 87-117.

TABLE 4-14 ANALYTICAL RESULTS FOR UNTREATED F006 WASTE (Continued)

	TCLP Concentration in Raw Waste Sample - F006 (ppm)								
	#1	#2	#3	#4	#5	#6	#7	#8	#9
BDAT CONSTITUENT									
Barium	--	--	1.41	--	0.38	--	--	0.53	0.28
Cadmium	--	2.21	1.13	0.02	23.6	0.3	0.06	0.18	--
Chromium	--	0.76	0.43	--	25.3	38.7	360	--	--
Copper	--	368	--	4.62	1.14	31.7	8.69	483	16.9
Lead	--	10.7	2.26	0.45	0.45	3.37	1.0	4.22	50.2
Nickel	0.71	22.7	1.1	0.52	9.78	730	152	644	16.1
Silver	--	0.14	0.20	0.16	0.08	0.12	0.05	0.31	--
Zinc	0.16	219	5.41	2,030	867	1,200	0.62	650	1.29

1 - Wastewater treatment sludge cake - no free liquid.
2 - Site closure excavation mud at auto part manufacturer. The waste sample is a mixture of F006 and F007.
3 - Waste treatment sludge from aircraft overhaul facility. The waste sample is a mixture of F006, D006, D007, and D008.
4 - Zinc electroplating sludge.
5 - Filter cake from electroplating wastewater treatment.
6 - Sludge from treatment of Cr, Cu, Ni, and Zn plating.
7 - Wastewater treatment sludge from plating on plastics.
8 - Wastewater treatment sludge.
9 - To be provided

Source: CWM Technical Note 87-117.

TABLE 4-15 ANALYTICAL RESULTS FOR TREATED F006 WASTE

	TCLP Concentration in Treated Sample - F006 (ppm)								
	#1	#2	#3	#4	#5	#6	#7	#8	#9
Mix Ratio	0.2	0.5	0.2	1.0	0.5	0.5	0.2	0.5	0.5
BDAT CONSTITUENT									
Barium	--	--	0.33	--	0.23	--	--	0.27	0.08
Cadmium	--	0.01	0.06	0.01	0.01	0.01	0.01	0.01	--
Chromium	--	0.39	0.08	--	0.30	0.38	1.21	--	--
Copper	--	0.25	--	0.15	0.27	0.29	0.42	0.32	0.46
Lead	--	0.36	0.30	0.21	0.34	0.36	0.38	0.37	0.27
Nickel	0.04	0.03	0.23	0.02	0.03	0.04	0.10	0.04	0.02
Silver	--	0.05	0.20	0.03	0.04	0.06	0.05	0.05	--
Zinc	0.03	0.01	0.05	0.01	0.04	0.03	0.02	0.02	<0.01

1 - Wastewater treatment sludge cake - no free liquid.
2 - Site closure excavation mud at auto part manufacturer. The waste sample is a mixture of F006 and F007.
3 - Waste treatment sludge from aircraft overhaul facility. The waste sample is a mixture of F006, D006, D007, and D008.
4 - Zinc electroplating sludge.
5 - Filter cake from electroplating wastewater treatment.
6 - Sludge from treatment of Cr, Cu, Ni, and Zn plating.
7 - Wastewater treatment sludge from plating on plastics.
8 - Wastewater treatment sludge.
9 - To be provided

Source: CWM Technical Note 87-117.

TABLE 4-16 CEMENT KILN DUST COMPOSITION DATA

Constituent	Concentration in mg/l		Other Characteristics
	Composition	TCLP/EP*	
Aluminum	31,000	NA	
Arsenic	38	<0.01	
Barium	92.7	2.74	
Cadmium	3.14	<0.01	
Chromium (total)	31.9	0.05	
Copper	44.8	0.16	
Iron (total)	15,200	NA	
Lead	156	0.29	
Magnesium	3,790	NA	
Mercury	<0.033	<0.001	
Nickel	12.6	0.02	
Selenium	8.67	0.03	
Silver	4.13	0.02	
Zinc	65.6	0.04	
Sodium	2300	NA	
Potassium	33,100	NA	
Calcium	41,900	NA	
Total Sulfide ppm			<8
Ash content %			99.8
Total residue @ 105 c%			100
Alkalinity as CAO%			56.16
pH 10% solution			12.55

NA - Not reported.
* - In the process of checking with CWM for the type of analysis performed.

Source: Special Waste Analysis Report dated June 15, 1987
provided be Chemical Waste Management, Technical Center.

TABLE 4-17 ANALYTICAL RESULTS FOR UNTREATED K101 SCRUBBER WATER [a]

		Untreated Scrubber Water			
		Sample Set 1 Total (mg/l)	Sample Set 2 Total (mg/l)	Sample Set 3 Total (mg/l)	Sample Set 4 Total (mg/l)
BDAT LISTED					
	Metals				
154	Antimony	404	296	136	137
155	Arsenic	426	504	307	91.7
156	Barium	0.425	0.462	0.447	0.480
157	Beryllium	<0.001	<0.001	<0.001	<0.001
158	Cadmium	<0.050	<0.500	<0.005	<0.500
159	Chromium	1.120	1.71	1.16	0.962
160	Copper	3.170	7.13	3.97	3.56
161	Lead	3.620	3.87	2.00	1.97
162	Mercury	0.040	0.109	0.069	0.0057
163	Nickel	0.649	1.210	0.907	0.983
164	Selenium	0.389	0.121	<0.050	<0.500
165	Silver	0.048	<0.007	<0.070	<0.070
166	Thallium	0.377	0.167	0.056	0.037
167	Vanadium	0.027	0.058	0.036	0.038
168	Zinc	10.9	19.3	13.8	14.8
NON-BDAT LISTED					
	Total Solids	10,400	32,000	18,500	22,600
	Total Suspended Solids	1,620	914	289	373
	Total Dissolved Solids	8,460	23,600	17,700	21,100

[a] - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 5-3 through 5-6.

TABLE 4-18 ANALYTICAL RESULTS FOR UNTREATED K102 SCRUBBER WATER [a]

		Untreated Scrubber Water					
		Sample Set 1 Total (mg/l)	Sample Set 2 Total (mg/l)	Sample Set 3 Total (mg/l)	Sample Set 4 Total (mg/l)	Sample Set 5 Total (mg/l)	Sample Set 6 Total (mg/l)
BDAT LISTED							
	Metals						
154	Antimony	591	513	627	489	291	712
155	Arsenic	341	495	641	663	668	713
156	Barium	0.207	0.198	0.375	0.560	0.648	0.323
157	Beryllium	<0.010	<0.001	<0.001	0.0017	0.0018	0.002
158	Cadmium	0.671	0.834	2.8	0.887	0.436	0.283
159	Chromium	0.606	0.372	0.379	0.410	0.606	0.565
160	Copper	1.120	1.170	1.220	1.310	1.690	1.490
161	Lead	0.245	0.081	0.132	0.567	0.323	<0.005
162	Mercury	0.018	0.022	0.036	0.053	0.036	0.041
163	Nickel	<0.220	<0.220	<0.220	0.092	0.228	0.018
164	Selenium	0.131	0.170	0.413	0.223	0.170	0.119
165	Silver	0.007	0.0099	0.011	0.013	0.016	0.014
166	Thallium	0.246	0.370	0.562	0.449	0.417	0.417
167	Vanadium	0.032	0.040	0.034	0.023	0.025	0.028
168	Zinc	1.280	1.230	1.340	1.460	1.850	1.790
NON-BDAT LISTED							
	Total Solids	6,200	5,130	5,380	8,260	8,920	9,160
	Total Suspended Solids	1,980	2,910	4,440	6,290	6,210	6,410
	Total Dissolved Solids	1,930	2,610	2,550	2,620	2,530	2,370

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a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-3 through 5-8.

TABLE 4-19 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]

SAMPLE SET 1

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
BDAT LIST			
Metals (mg/l)			
154 Antimony	3.740	2.9	<0.640
155 Arsenic	826	1,260	0.415
156 Barium	<0.020	0.025	<0.200
157 Beryllium	0.021	<0.020	<0.020
158 Cadmium	2.990	3.980	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<1.2	<1.200	0.266
161 Lead	0.044	0.298	<0.005
162 Mercury	0.019	0.036	0.0014
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025	<0.050	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<0.100	<0.010	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.473	1.220	0.709

Continued

TABLE 4-19 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]
(Continued)

SAMPLE SET 1

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
Incoming Waste Arsenic Content (ppm)	500 - 5,000	826	1,260
Untreated Waste pH	2 - 8	10.94	4.04
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	1.5	2.2
Mixing Time (min)	15 - 30	25	30
Amount of Flocculant Added (gal)	2 - 5	5	3
Waste Volume (gal)	8,000	8,850	8,030
Treated Waste pH	11.2 - 11.5	12.18	12.34
Reaction Temperature (°C)	Ambient	27.1	28.1
Manganese Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	143	
Untreated Waste pH	11.2 - 11.5	12.01	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	9.5	
Mixing Time (min)	30	35	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,200	16,200	
Treated Waste pH	8.0 - 8.5	7.39	
Reaction Temperature (°C)	Ambient	25.6	
Ferric Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	10 - 100	23.4	
Untreated Waste pH	8.0 - 8.5	7.42	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	100	
Molar Ratio of Treatment Chemical to Arsenic	9:1	8.8	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	15,700	
Treated Waste pH	4.4 - 4.6	3.79	
Reaction Temperature (°C)	Ambient	32.9	

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*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.

a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 4-20 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION[a]

SAMPLE SET 2

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
BDAT LIST			
Metals (mg/l)			
154 Antimony	1.090	1.460	<0.640
155 Arsenic	427	960	2.000
156 Barium	0.325	<0.020	0.032
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	1.090	3.080	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<1.200	0.321
161 Lead	0.075	<0.005	0.029
162 Mercury	0.076	0.142	0.0043
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025	<0.025	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<0.010	<0.010	0.011
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	1.000	0.749	1.150

Continued

TABLE 4-20 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]
(Continued)

SAMPLE SET 2

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
Incoming Waste Arsenic Content (ppm)	500 - 5,000	427	960
Untreated Waste pH	2 - 8	7.06	2.17
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	4.8	1.5
Mixing Time (min)	15 - 30	25	20
Amount of Flocculant Added (gal)	2 - 5	3	2
Waste Volume (gal)	8,000	7,950	7,650
Treated Waste pH	11.2 - 11.5	12.82	11.96
Reaction Temperature (°C)	Ambient	27.0	35.2
Manganese Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	147	
Untreated Waste pH	11.2 - 11.5	11.80	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	11.2	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,200	13,400	
Treated Waste pH	8.0 - 8.5	8.06	
Reaction Temperature (°C)	Ambient	27.6	
Ferric Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	10 - 100	35.9	
Untreated Waste pH	8.0 - 8.5	7.60	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	100	
Molar Ratio of Treatment Chemical to Arsenic	9:1	6.3	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	14,300	
Treated Waste pH	4.4 - 4.6	4.17	
Reaction Temperature (°C)	Ambient	26.4	

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*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.
a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 4-21 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]

SAMPLE SET 3

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
BDAT LIST			
Metals (mg/l)			
154 Antimony	0.914	4.110	<0.640
155 Arsenic	1,280	706	0.513
156 Barium	0.269	<0.020	<0.020
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	3.250	2.590	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<0.120	0.267
161 Lead	0.279	0.078	0.025
162 Mercury	0.112	0.190	0.0094
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.050	<0.005	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<1.000	<0.010	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.617	1.170	0.743

Continued

TABLE 4-21 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]
(Continued)

SAMPLE SET 3

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
Incoming Waste Arsenic Content (ppm)	500 - 5,000	1,280	706
Untreated Waste pH	2 - 8	2.01	7.61
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	2.0	1.8
Mixing Time (min)	15 - 30	25	30
Amount of Flocculant Added (gal)	2 - 5	5	5
Waste Volume (gal)	8,000	8,700	8,100
Treated Waste pH	11.2 - 11.5	12.09	12.31
Reaction Temperature (°C)	Ambient	30.8	41.7
Manganese Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	205	
Untreated Waste pH	11.2 - 11.5	12.41	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	7.0	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,200	15,400	
Treated Waste pH	8.0 - 8.5	7.34	
Reaction Temperature (°C)	Ambient	30.9	
Ferric Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	10 - 100	15.0	
Untreated Waste pH	8.0 - 8.5	7.17	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	100	
Molar Ratio of Treatment Chemical to Arsenic	9:1	13.3	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	16,200	
Treated Waste pH	4.4 - 4.6	4.00	
Reaction Temperature (°C)	Ambient	29.2	

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*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.

[a] - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 4-22 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]

SAMPLE SET 4

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
BDAT LIST			
Metals (mg/l)			
154 Antimony	1.590	3.160	<0.640
155 Arsenic	1,340	399	0.418
156 Barium	0.270	0.251	0.035
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	2.860	0.977	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<0.120	0.240
161 Lead	0.478	<0.050	<0.010
162 Mercury	0.076	0.040	0.0039
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025	<0.025	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<10	<0.010	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.210	0.636	0.743

Continued

TABLE 4-22 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]
(Continued)

SAMPLE SET 4

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
Incoming Waste Arsenic Content (ppm)	500 - 5,000	1,340	399
Untreated Waste pH	2 - 8	6.46	12.12
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	2.2	5.8
Mixing Time (min)	15 - 30	25	20
Amount of Flocculant Added (gal)	2 - 5	3	5
Waste Volume (gal)	8,000	7,280	7,130
Treated Waste pH	11.2 - 11.5	11.84	12.86
Reaction Temperature (°C)	Ambient	30.7	26.7
Manganese Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	125	
Untreated Waste pH	11.2 - 11.5	12.35	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	10.3	
Mixing Time (min)	30	35	
Amount of Flocculant Added (gal)	3 - 5	3	
Waste Volume (gal)	16,200	17,500	
Treated Waste pH	8.0 - 8.5	7.49	
Reaction Temperature (°C)	Ambient	26.8	
Ferric Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	10 - 100	26.5	
Untreated Waste pH	8.0 - 8.5	7.49	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	100	
Molar Ratio of Treatment Chemical to Arsenic	9:1	7.2	
Mixing Time (min)	30	35	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	17,000	
Treated Waste pH	4.4 - 4.6	4.12	
Reaction Temperature (°C)	Ambient	26.2	

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*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.
a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 4-23 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]

SAMPLE SET 5

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
BDAT LIST			
Metals (mg/l)			
154 Antimony	0.640	3.410	<0.640
155 Arsenic	1,670	717	0.440
156 Barium	0.509	0.226	0.037
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	3.640	1.500	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<0.120	0.506
161 Lead	0.371	0.197	<0.025
162 Mercury	0.0034	0.139	0.0061
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025	<0.025	<0.100
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<10	<10	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.164	0.974	1.710

Continued

TABLE 4-23 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION [a]
(Continued)

SAMPLE SET 5

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		**Basin #5**	**Basin #6**
Incoming Waste Arsenic Content (ppm)	500 - 5,000	1,670	717
Untreated Waste pH	2 - 8	1.79**	6.97
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	1.3	2.1
Mixing Time (min)	15 - 30	25	30
Amount of Flocculant Added (gal)	2 - 5	3	5
Waste Volume (gal)	8,000	7,280	7,130
Treated Waste pH	11.2 - 11.5	12.02	11.86
Reaction Temperature (°C)	Ambient	20.0	48.0
Manganese Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	302	
Untreated Waste pH	11.2 - 11.5	11.93	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	4.7	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,200	15,700	
Treated Waste pH	8.0 - 8.5	7.02	
Reaction Temperature (°C)	Ambient	33.7	
Ferric Sulfate Precipitator:			
Incoming Waste Arsenic Content (ppm)	10 - 100	107.0	
Untreated Waste pH	8.0 - 8.5	7.34	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	250	
Molar Ratio of Treatment Chemical to Arsenic	9:1	4.7	
Mixing Time (min)	30	40	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	16,000	
Treated Waste pH	4.4 - 4.6	3.91	
Reaction Temperature (°C)	Ambient	31.5	

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*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.

**This value was measured on a sample taken directly from the feed line to the basin.

a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

5. SELECTION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY FOR K101 AND K102

5.1 Introduction

This section describes how the data collected by the Agency were evaluated to determine which demonstrated treatment technology system represents BDAT for waste codes K101 and K102. As discussed in detail in Section 1, this determination essentially involves ascertaining which of the "demonstrated" technologies will provide the "best" treatment and, at the same time, determining whether that technology is "available" (i.e., the technology can be purchased or licensed and provides substantial treatment).

The demonstrated treatment technology under consideration for nonwastewaters is rotary kiln incineration and metals stabilization of the kiln ash. The demonstrated treatment technology under consideration for wastewaters is chemical precipitation and metals stabilization of the nonwastewater precipitate. As discussed in Sections 3 and 4, the Agency collected performance data for the treatment of K101 and K102 nonwastewaters from one treatment technology system: rotary kiln incineration. No additional performance data were available for the treatment of K101 and K102 wastewaters or nonwastewaters.

The topics covered in this section include descriptions of the data screening process employed, the methods used to ensure accuracy of the analytical data, and the analysis of variance (ANOVA) tests performed in identifying the best technology for the treatment of K101 and K102 wastes.

In general, performance data are screened according to the following three conditions:

- Proper design and operation of the treatment system;
- The existence of quality assurance/quality control measures in the data analysis; and
- The use of proper analytical tests in assessing treatment performance.

Sets of performance data that do not meet these three conditions are not considered in the selection of BDAT. In addition, if performance data indicate that the treatment system was not well designed and well operated at the time of testing, these data also would not be used.

The remaining performance data are then corrected to account for incomplete recovery of certain constituents during the analyses. Finally, in cases where the Agency has adequate performance data for treatment of the waste by more than one technology, an analysis of variance (ANOVA) test is used to select the best treatment technology.

5.2 Review of Performance Data

5.2.1 Nonwastewaters

Six data sets were collected by the Agency for treatment of waste code K102 and four data sets were collected by the Agency for treatment of K101, both by rotary kiln incineration. These data sets are provided in Tables 4-1 through 4-12 in the preceding section. The data sets were evaluated to determine whether any of the data represented poor design or poor operation of the treatment systems. None of the data sets were deleted after this evaluation. Of the six data sets in K102, insufficient ash was generated for Sample Sets 5 and 6. No ash was generated out of the four data sets in K101. Therefore, three ash samples from the kiln walls were substituted for the treated waste samples in K101. Insufficient ash was generated during the incineration of K101 and K102; therefore, stabilization of the ash could not be performed. In addition, no performance data were available for treatment of the resulting scrubber water.

Performance data were not collected for metals stabilization of the incinerator ash or the scrubber water precipitate for K101 and K102. The Agency will thus consider performance data for K101 and K102 that have been transferred from similar wastes based on waste characteristics affecting performance. The available data collected by the Agency for F006 were used as performance data for stabilization of the K101 and K102 incinerator ash and precipitate residuals. These data were evaluated to determine whether any of the data represented poor design or poor operation of the system. Nine of the available data sets were used for the development of treatment standards for nonwastewaters from K101 and K102.

Performance data for stabilization of the kiln ash can be found in Section 4 of this document.

5.2.2 Wastewaters

Performance data were not collected for chemical precipitation of K101 and K102 wastewaters. Five data sets from the treatment of D004 were collected by the Agency for chemical precipitation. The five data sets for D004 were transferred to the resulting K101 and K102 scrubber water based on waste characteristics affecting performance. None of the data sets in D004 were deleted because of poor design or poor operation of the treatment system during the time data were being collected. Performance data for chemical precipitation of the scrubber waters can be found in the Onsite Engineering Report for waste characterized as EPA hazardous waste, D004.

5.3 Accuracy Correction of Performance Data

After data were eliminated from consideration for analysis of BDAT based on the screening tests, the Agency adjusted the data using analytical recovery values. Recovery values take into account analytical interferences and incomplete recoveries associated with the chemical makeup of the sample. The recovery values are listed in Appendix B. The Agency developed the recovery data (also referred to as accuracy data), by first analyzing a waste for a given constituent and then adding a known amount of the same constituent (i.e., spike) to the waste material. The total amount recovered after spiking, minus the initial concentration in the sample, divided by the amount added, is the recovery value. At least two recovery values were calculated for spiked constituents, and the analytical data were adjusted for accuracy using the lowest recovery value for each constituent. This adjustment was accomplished by calculating an accuracy factor from the percent recoveries for each selected constituent. The reciprocal of the lower of the two recovery values multiplied by 100, yields the accuracy factor.

The corrected concentration for each sample set is obtained by multiplying the accuracy factor by the raw data value. Should the corrected value be lower than the detection limit,* the detection limit value is substituted for the corrected value.

In instances where a selected constituent was not detected in the treated waste, the treated value for that constituent was assumed to be the detection limit. The detection limit is corrected in the same manner as described above with one exception: the detection limit is not corrected to a value lower than the detection limit. The EPA does not consider values lower than the detection limit to be valid.

The recovery values used and accuracy factors calculated for the selected constituents are presented in Appendix D.

An arithmetic average value, representing the treated waste concentration, was calculated for each selected constituent from the corrected values. The accuracy-corrected data, averages, and variability factors are presented in Tables 7-1 and 7-2 for nonwastewaters and in Table 7-3 for wastewaters. These adjusted values for the treatment technology systems consisting of rotary kiln incineration followed by stabilization of the kiln ash and chemical precipitation of the scrubber water followed by stabilization of the precipitate were then used to determine BDAT for waste codes K101 and K102.

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* A detection limit is defined as the practical quantification limit, PQL, that is five times the method detection limit achievable when using an EPA-approved analytical method specified for a particular analysis (i.e., constituent of interest) in SW-846, 3rd Edition (USEPA 1986a).

5.4 Statistical Comparison of Performance Data

In cases where the Agency has adequate performance data on treatment of the same or similar wastes using more than one technology, an analysis of variance (ANOVA) test is performed to determine whether one of the technologies provides significantly better treatment compared to the others. In cases where a particular treatment technology is shown to provide the best treatment, the treatment standards will be based on this best technology.

5.5 BDAT for K101/K102 Wastes

In the case of K101 and K102 wastes, the Agency does not have performance data for any demonstrated technology beyond rotary kiln incineration followed by stabilization of the kiln ash and chemical precipitation of the scrubber water followed by stabilization of the precipitate. The Agency, therefore, has no reason to believe that the levels of performance achieved by this technology can be improved upon. Thus, the Agency has determined that performance achieved by incineration followed by stabilization of the kiln ash and chemical precipitation of the scrubber water followed by stabilization of the precipitate represents BDAT.

Rotary kiln incineration and metals stabilization are judged to be available to treat K101 and K102 nonwastewaters. Chemical precipitation is judged to be available to treat K101 and K102 wastewaters. The Agency believes these technologies to be available because they are (1) commercially available and (2) provide a substantial reduction in the leachable levels of BDAT list constituents present in wastes K101 and K102. EPA's determination of substantial treatment is discussed below.

Substantial treatment for K101 and K102 wastes is based on the observations found in Tables 5-1 and 5-2. In the incineration step, 2-nitroaniline is reduced from as much as 191,000 mg/kg to <2 mg/kg and 2-nitrophenol from 870 mg/kg to <1 mg/kg. Performance data for stabilization and chemical precipitation were transferred from F006 and D004, respectively, and are found in Tables 5-1 and 5-2.

The Agency believes the reduction in the range and magnitude of these hazardous constituents to be substantial. For Low Arsenic K101 and K102 wastewaters and nonwastewaters, rotary kiln incineration followed by stabilization of K101 and K102 kiln ash and precipitated metals from the scrubber waters and chemical precipitation of the scrubber waters has been determined to be demonstrated and best, has provided substantial treatment, and is commercially available; it therefore represents BDAT.

TABLE 5-1 Nonwastewater Data Showing Substantial Treatment

EPA Collected Performance Data From Incineration

Constituent	Total Composition (mg/kg) Untreated	Treated
K101		

2-Nitroaniline*	<172,000 - 191,000	<2
K102		

2-Nitrophenol*	220 - 870	<1

* - Constituent is not on the BDAT list

Performance Data Transferred From F006*

BDAT LIST CONSTITUENT	TCLP Concentration - F006 (ppm) Untreated	Treated
Barium	0.28 - 1.41	0.08 - 0.33
Cadmium	0.02 - 23.6	0.01 - 0.06
Chromium	0.43 - 360	0.08 - 1.21
Copper	1.14 - 483	0.15 - 0.46
Lead	0.45 - 50.2	0.21 - 0.38
Nickel	0.52 - 730	0.02 - 0.23
Silver	0.05 - 0.31	0.03 - 0.20
Zinc	0.16 - 2,030	<0.01 - 0.05

* - For individual sample points see Background Document for F006.

Source: CWM Technical Note 87-117.

TABLE 5-2 D004 Wastewater Data Showing Substantial Treatment[a]

BDAT List Constituent	UNTREATED WASTE Basin #5	 Basin #6	TREATED WASTE
Metals (mg/l)			
154 Antimony	0.640 - 3.740	1.460 - 4.110	<0.640
155 Arsenic	427 - 1,670	399 - 1,260	0.415 - 2.000
156 Barium	<0.020 - 0.509	<0.020 - 0.251	<0.020 - <0.200
157 Beryllium	<0.020 - 0.021	<0.020	<0.020
158 Cadmium	1.090 - 3.640	0.977 - 3.980	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120 - <1.20	<1.200	0.240 - 0.506
161 Lead	0.044 - 0.478	<0.005 - 0.298	<0.005 - 0.029
162 Mercury	0.0034 - 0.112	0.036 - 0.190	0.0014 - 0.0094
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025 - <0.050	<0.005 - <0.050	<0.050 - <0.100
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<0.010 - <10	<0.010 - <10	<0.010 - 0.011
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.164 - 1.000	0.636 - 1.220	0.709 - 1.710

[a] - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

6. DETERMINATION OF REGULATED CONSTITUENTS

As discussed in Section 1, the Agency has developed a list of hazardous constituents (Table 1-1) from which the constituents to be regulated are selected. EPA may revise this list as additional data and information become available. The list is divided into the following categories: volatile organics, semivolatile organics, metals, inorganics other than metals, organochlorine pesticides, phenoxyacetic acid herbicides, organophosphorous insecticides, PCBs, and dioxins and furans.

This section describes the process used to select the constituents to be regulated for K101/K102. The process involves developing a list of potential regulated constituents and then eliminating those constituents that would not be treated by the chosen BDAT or that would be controlled by regulation of the remaining constituents.

6.1 BDAT List Constituents Detected in the Untreated and Treated Waste

Using EPA-collected data, the Agency identified those constituents that were detected in the untreated waste and the waste treated by incineration. EPA collected four sets of data at one facility for waste code K101 (see the Onsite Engineering Report for K101 for more details) to evaluate the treatment of waste code K101 by incineration.* All four data sets were used to identify the constituents detected in the untreated waste, and three ash samples were used to identify constituents in the treated waste. EPA also collected six sets of data at this facility for waste code K102 (see the Onsite Engineering Report for K102 for more details) to evaluate the treatment of waste code K102 by incineration. All six data sets were used to identify the constituents detected in the untreated waste, and four of the six data sets were used to identify constituents detected in the treated waste. The detection limits for the BDAT list of constituents for K101 and K102 are presented in Appendix C.

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* Data for stabilization of kiln ash and scrubber water precipitate were transferred from the treatment of EPA hazardous waste F006. Data for chemical precipitation of the scrubber waters were transferred from the treatment of EPA hazardous waste D004 (wastes that exhibited characteristics for EP toxicity for arsenic).

Tables 6-1 and 6-2 present the BDAT list as discussed in Section 1. They indicates which of the BDAT list constituents were analyzed in the untreated and treated waste for K101 and K102.

As shown in Table 6-1, the following constituents were detected in the untreated waste K101: acetone, toluene, 2-nitroaniline, antimony, arsenic, barium, chromium, copper, lead, mercury, nickel, silver, vanadium, zinc, fluoride, and sulfide. The following constituents were detected after incineration of the K101 waste in the kiln ash: antimony, arsenic, barium, beryllium, chromium, copper, lead, nickel, silver, vanadium, zinc, and sulfide.

The following constituents were detected in the scrubber waters generated from incineration: bis(2-ethylhexyl) phthalate, antimony, arsenic, barium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

TABLE 6-1 BDAT List Constituents in Untreated K101 Waste [a]

	Parameter	Untreated K101 Detection Status (mg/kg)	Untreated K101 Believed to be Present	Scrubber Wastewater (mg/l)
	Volatiles			
222	Acetone	<50 - 81		ND
1	Acetonitrile	ND		ND
2	Acrolein	ND		ND
3	Acrylonitrile	ND		ND
4	Benzene	ND		ND
5	Bromodichloromethane	ND		ND
6	Bromomethane	ND		ND
223	n-Butyl alcohol	NA		NA
7	Carbon Tetrachloride	ND		ND
8	Carbon disulfide	ND		ND
9	Chlorobenzene	ND		ND
10	2-Chloro-1,3-butadiene	ND		ND
11	Chlorodibromomethane	ND		ND
12	Chloroethane	ND		ND
13	2-Chloroethyl vinyl ether	ND		ND
14	Chloroform	ND		ND
15	Chloromethane	ND		ND
16	3-Chloropropene	ND		ND
17	1,2-Dibromo-3-chloropropane	ND		ND
18	1,2-Dibromoethane	ND		ND
19	Dibromomethane	ND		ND
20	trans-1,4-Dichloro-2-butene	ND		ND
21	Dichlorodifluoromethane	ND		ND
22	1,1-Dichloroethene	ND		ND
23	1,2-Dichloroethane	ND		ND
24	1,1-Dichloroethylene	ND		ND
25	trans-1,2-Dichloroethene	ND		ND
26	1,2-Dichloropropane	ND		ND
27	trans-1,3-Dichloropropene	ND		ND
28	cis-1,3-Dichloropropene	ND		ND
29	1,4-Dioxane	ND		ND
224	2-Ethoxyethanol	NA		NA
225	Ethyl acetate	NA		NA
226	Ethyl benzene	ND		ND
30	Ethyl cyanide	ND		ND
227	Ethyl ether	NA		NA
31	Ethyl methacrylate	ND		ND
214	Ethylene oxide	ND		ND
32	Iodomethane	ND		ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma for K101. Tables 5-2 to 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-1 BDAT List Constituents in Untreated K101 Waste [a] (Continued)

	Parameter	Untreated K101		Scrubber Wastewater (mg/l)
		Detection Status (mg/kg)	Believed to be Present	
	Volatiles (continued)			
33	Isobutyl alcohol	ND		ND
228	Methanol	NA		NA
34	Methyl ethyl ketone	ND		ND
229	Methyl isobutyl ketone	NA		NA
35	Methyl methacrylate	ND		ND
37	Methylacrylonitrile	ND		ND
38	Methylene chloride	ND		ND
230	2-Nitropropane	NA		NA
39	Pyridine	ND		ND
40	1,1,1,2-Tetrachloroethane	ND		ND
41	1,1,2,2-Tetrachloroethane	ND		ND
42	Tetrachloroethene	ND		ND
43	Toluene	<25 - 42		ND
44	Tribromomethane	ND		ND
45	1,1,1-Trichloroethane	ND		ND
46	1,1,2-Trichloroethane	ND		ND
47	Trichloroethene	ND		ND
48	Trichloromonofluromethane	ND		ND
49	1,2,3-Trichloropropane	ND		ND
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA		NA
50	Vinyl chloride	ND		ND
215	1,2-Xylene	NA		NA
216	1,3-Xylene	NA		NA
217	1,4-Xylene	NA		NA
	Semivolatiles			
51	Acenaphthalene	ND		ND
52	Acenaphthene	ND		ND
53	Acetophenone	ND		ND
54	2-Acetylaminofluorene	ND		ND
55	4-Aminobiphenyl	ND		ND
56	Aniline	ND		ND
57	Anthracene	ND		ND
58	Aramite	NA		NA
59	Benz(a)anthracene	ND		ND
218	Benzal chloride	NA		NA
60	Benzenethiol	ND		ND
61	Benzidine	ND		ND
62	Benzo(a)pyrene	ND		ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma for K101. Tables 5-2 to 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-1 BDAT List Constituents in Untreated K101 Waste [a](Continued)

	Parameter	Untreated K101 Detection Status (mg/kg)	Untreated K101 Believed to be Present	Scrubber Wastewater (mg/l)
	Semivolatiles (continued)			
63	Benzo(b)fluoranthene	ND		ND
64	Benzo(ghi)perylene	ND		ND
65	Benzo(k)fluoranthene	ND		ND
66	p-Benzoquinone	ND		ND
67	Bis(2-chloroethoxy)ethane	ND		ND
68	Bis(2-chloroethyl)ether	ND		ND
69	Bis(2-chloroisopropy)ether	ND		ND
70	Bis(2-ethylhexyl)phthalate	ND		<0.011 - 0.020
71	4-Bromophenyl phenyl ether	ND		ND
72	Butyl benzyl phthlate	ND		ND
73	2-sec-Butyl-4,6-dinitrophenol	ND		ND
74	p-Chloroaniline	ND		ND
75	Chlorobenzilate	NA		NA
76	p-Chloro-m-cresol	ND		ND
77	2-Chloronaphthalene	ND		ND
78	2-Chlorophenol	ND		ND
79	3-Chloropropionitrile	NA		NA
80	Chrysene	ND		ND
81	ortho-Cresol	ND		ND
82	para-Cresol	ND		ND
232	Cyclohexanone	ND		ND
83	Dibenz(a,h)anthracene	ND		ND
84	Dibenzo(a,e)pyrene	NA		NA
85	Dibenzo(a,i)pyrene	NA		NA
86	m-Dichlorobenzene	ND		ND
87	o-Dichlorobenzene	ND		ND
88	p-Dichlorobenzene	ND		ND
89	3,3'-Dichlorobenzidine	ND		ND
90	2,4-Dichlorophenol	ND		ND
91	2,6-Dichlorophenol	ND		ND
92	Diethyl phthalate	ND		ND
93	3,3'-Dimethyoxlbenzidine	ND		ND
94	p-Dimethylaminoazobenzene	ND		ND
95	3,3'-Dimethylbenzidine	ND		ND
96	2,4-Dimethylphenol	ND		ND
97	Dimethyl phthalate	ND		ND
98	Di-n-butyl p[illegible]ate	ND		ND
99	1,4-Dinitrob[illegible]	ND		ND
100	4,6-Dinitro-o-cresol	ND		ND
101	2,4-Dinitrophenol	ND		ND

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a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma for K101. Tables 5-2 to 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-1 BDAT List Constituents in Untreated K101 Waste [a] (Continued)

	Parameter	Untreated K101 Detection Status (mg/kg)	Untreated K101 Believed to be Present	Scrubber Wastewater (mg/l)
	Semivolatiles (cont.)			
102	2,4-Dinitrotoluene	ND		ND
103	2,6-Dinitrotoluene	ND		ND
104	Di-n-octyl phthalate	ND		ND
105	Di-n-propylnitrosamine	ND		ND
106	Diphenylamine	ND		ND
219	Diphenylnitrosamine	NA		NA
107	1,2-Diphenylhydrazine	ND		ND
108	Fluoranthene	ND		ND
109	Fluorene	ND		ND
110	Hexachlorobenzene	ND		ND
111	Hexachlorobutadiene	ND		ND
112	Hexachlorocyclopentadiene	ND		ND
113	Hexachloroethane	ND		ND
114	Hexachlorophene	NA		NA
115	Hexachloropropene	ND		ND
116	Indeno(1,2,3-cd)pyrene	ND		ND
117	Isosafrole	ND		ND
118	Methapyrilene	NA		NA
119	3-Methycholanthrene	ND		ND
120	4,4'-Methylenebis(2-chloroaniline)	ND		ND
36	Methyl methanesulfonate	ND		ND
121	Napthalene	ND		ND
122	1,4-Naphthoquinone	NA		NA
123	1-Napthylamine	ND		ND
124	2-Napthylamine	ND		ND
***	2-Nitroaniline	<172,000 - 191,000		ND
125	p-Nitroaniline	ND		ND
126	Nitrobenzene	ND		ND
127	4-Nitrophenol	ND		ND
128	N-Nitrosodi-n-butylamine	ND		ND
129	N-Nitrosodiethylamine	ND		ND
130	N-Nitrosodimethylamine	ND		ND
131	N-Nitrosomethylethylamine	ND		ND
132	N-Nitrosomorpholine	ND		ND
133	N-Nitrosopiperidine	ND		ND
134	N-Nitrosopyrrolidine	ND		ND
135	5-Nitro-o-toluidine	ND		ND
136	Pentachlorobenzene	ND		ND
137	Pentachloroethane	NA		NA
138	Pentachloronitrobenzene	ND		ND

***- Not on BDAT List.

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma for K101. Tables 5-2 to 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-1 BDAT List Constituents in Untreated K101 Waste [a] (Continued)

Parameter		Untreated K101 Detection Status (mg/kg)	Believed to be Present	Scrubber Wastewater (mg/l)
Semivolatiles (cont.)				
139	Pentachlorophenol	ND		ND
140	Phenacetin	ND		ND
141	Phenanthrene	ND		ND
142	Phenol	ND		ND
220	Phthalic anhydride	ND		ND
143	2-Picoline	ND		ND
144	Pronamide	ND		ND
145	Pyrene	ND		ND
146	Resorcinol	NA		NA
147	Safrole	ND		ND
148	1,2,4,5-Tetrachlorobenzene	ND		ND
149	2,3,4,6-Tetrachlorophenol	ND		ND
150	1,2,4-Trichlorobenzene	ND		ND
151	2,4,5-Trichlorophenol	ND		ND
152	2,4,6-Trichlorophenol	ND		ND
153	Tris(2,3-dibromopropyl)phosphate	ND		ND
Metals				
154	Antimony	87 - 104		136 - 404
155	Arsenic	244 - 360		91.7 - 504
156	Barium	288 - 294		0.425 - 0.480
157	Beryllium	ND		ND
158	Cadmium	ND		ND
159	Chromium	206 - 261		0.962 - 1.71
221	Chromium (hexavalent)	ND		ND
160	Copper	417 - 554		3.17 - 7.13
161	Lead	6.3 - 8.2		1.97 - 3.87
162	Mercury	<0.1		0.0057 - 0.109
163	Nickel	262 - 297		0.649 - 1.21
164	Selenium	ND		<0.050 - <0.500
165	Silver	<0.70 - 0.86		<0.007 - <0.070
166	Thallium	ND		<0.037 - 0.377
167	Vanadium	27 - 31		0.027 - 0.058
168	Zinc	132 - 173		10.9 - 19.3
Inorganics				
169	Cyanide	ND		ND
170	Fluoride	2.02		2.02
171	Sulfide	13.6 - 20.5		6.4 - 8.7

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a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma for K101. Tables 5-2 to 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

** - Indicates that only sample set 3 was analyzed for this constituent.

Continued

TABLE 6-1 BDAT List Constituents in Untreated K101 Waste [a] (Continued)

Parameter	Untreated K101 Detection Status (mg/kg)	Untreated K101 Believed to be Present	Scrubber Wastewater (mg/l)
Organochlorine Pesticides			
172 Aldrin	NA		NA
173 alpha-BHC	NA		NA
174 beta-BHC	NA		NA
175 delta-BHC	NA		NA
176 gamma-BHC	NA		NA
177 Chlordane	NA		NA
178 DDD	NA		NA
179 DDE	NA		NA
180 DDT	NA		NA
181 Dieldrin	NA		NA
182 Endosulfan I	NA		NA
183 Endosulfan II	NA		NA
184 Endrin	NA		NA
185 Endrin aldehyde	NA		NA
186 Heptachlor	NA		NA
187 Heptachlor epoxide	NA		NA
188 Isodrin	NA		NA
189 Kepone	NA		NA
190 Mehoxychlor	NA		NA
191 Toxaphene	NA		NA
Phenoxyacetic Acid Herbicides			
192 2,4-Dichlorophenoxyacetic acid	NA		NA
193 Silvex	NA		NA
194 2,4,5-T	NA		NA
Organophosphorous Insecticides			
195 Disulfoton	NA		NA
196 Famphur	NA		NA
197 Methyl parathion	NA		NA
198 Paration	NA		NA
199 Phorate	NA		NA
PCBs**			
200 Aroclor 1016	ND		ND
201 Aroclor 1221	ND		ND
202 Aroclor 1232	ND		ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma for K101. Tables 5-2 to 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-1 BDAT List Constituents in Untreated K101 Waste [a] (Continued)

Parameter	Untreated K101 Detection Status (mg/kg)	Believed to be Present	Scrubber Wastewater (mg/l)
PCBs** (continued)			
203 Aroclor 1242	ND		ND
204 Aroclor 1248	ND		ND
205 Aroclor 1254	ND		ND
206 Aroclor 1260	ND		ND
Dioxins and Furans**			
207 Hexachlorodibenzo-p-dioxins	ND		ND
208 Hexachlorodibenzofuran	ND		ND
209 Pentachlorodibenzo-p-dioxins	ND		ND
210 Pentachlorodibenzofuran	ND		ND
211 Tetrachlorodibenzo-p-dioxins	ND		ND
212 Tetrachlorodibenzofuran	ND		ND
213 2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND		ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 5-2 through 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste [a]

	Parameter	Untreated K102 Detection Status (mg/kg)	Untreated K102 Believed to be Present	Scrubber Wastewater (mg/l)
	Volatiles			
222	Acetone	ND		ND
1	Acetonitrile	ND		ND
2	Acrolein	ND		ND
3	Acrylonitrile	ND		ND
4	Benzene	ND		ND
5	Bromodichloromethane	ND		ND
6	Bromomethane	ND		ND
223	n-Butyl alcohol	NA		NA
7	Carbon Tetrachloride	ND		ND
8	Carbon disulfide	ND		ND
9	Chlorobenzene	ND		ND
10	2-Chloro-1,3-butadiene	ND		ND
11	Chlorodibromomethane	ND		ND
12	Chloroethane	ND		ND
13	2-Chloroethyl vinyl ether	ND		ND
14	Chloroform	ND		ND
15	Chloromethane	ND		ND
16	3-Chloropropene	ND		ND
17	1,2-Dibromo-3-chloropropane	ND		ND
18	1,2-Dibromoethane	ND		ND
19	Dibromomethane	ND		ND
20	trans-1,4-Dichloro-2-butene	ND		ND
21	Dichlorodifluoromethane	ND		ND
22	1,1-Dichloroethene	ND		ND
23	1,2-Dichloroethane	ND		ND
24	1,1-Dichloroethylene	ND		ND
25	trans-1,2-Dichloroethene	ND		ND
26	1,2-Dichloropropane	ND		ND
27	trans-1,3-Dichloropropene	ND		ND
28	cis-1,3-Dichloropropene	ND		ND
29	1,4-Dioxane	ND		ND
224	2-Ethoxyethanol	NA		NA
225	Ethyl acetate	NA		NA
226	Ethyl benzene	ND		ND
30	Ethyl cyanide	ND		ND
227	Ethyl ether	NA		NA
31	Ethyl methacrylate	ND		ND
214	Ethylene oxide	ND		ND
32	Iodomethane	ND		ND

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a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 to 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste [a]

	Parameter	Untreated K102		Scrubber Wastewater (mg/l)
		Detection Status (mg/kg)	Believed to be Present	
	Volatiles			
222	Acetone	ND		ND
1	Acetonitrile	ND		ND
2	Acrolein	ND		ND
3	Acrylonitrile	ND		ND
4	Benzene	ND		ND
5	Bromodichloromethane	ND		ND
6	Bromomethane	ND		ND
223	n-Butyl alcohol	NA		NA
7	Carbon Tetrachloride	ND		ND
8	Carbon disulfide	ND		ND
9	Chlorobenzene	ND		ND
10	2-Chloro-1,3-butadiene	ND		ND
11	Chlorodibromomethane	ND		ND
12	Chloroethane	ND		ND
13	2-Chloroethyl vinyl ether	ND		ND
14	Chloroform	ND		ND
15	Chloromethane	ND		ND
16	3-Chloropropene	ND		ND
17	1,2-Dibromo-3-chloropropane	ND		ND
18	1,2-Dibromoethane	ND		ND
19	Dibromomethane	ND		ND
20	trans-1,4-Dichloro-2-butene	ND		ND
21	Dichlorodifluoromethane	ND		ND
22	1,1-Dichloroethene	ND		ND
23	1,2-Dichloroethane	ND		ND
24	1,1-Dichloroethylene	ND		ND
25	trans-1,2-Dichloroethene	ND		ND
26	1,2-Dichloropropane	ND		ND
27	trans-1,3-Dichloropropene	ND		ND
28	cis-1,3-Dichloropropene	ND		ND
29	1,4-Dioxane	ND		ND
224	2-Ethoxyethanol	NA		NA
225	Ethyl acetate	NA		NA
226	Ethyl benzene	ND		ND
30	Ethyl cyanide	ND		ND
227	Ethyl ether	NA		NA
31	Ethyl methacrylate	ND		ND
214	Ethylene oxide	ND		ND
32	Iodomethane	ND		ND

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a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 to 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste[a] (Continued)

	Parameter	Untreated K102		Scrubber Wastewater (mg/l)
		Detection Status (mg/kg)	Believed to be Present	
	Volatiles (continued)			
33	Isobutyl alcohol	ND		ND
228	Methanol	NA		NA
34	Methyl ethyl ketone	ND		ND
229	Methyl isobutyl ketone	NA		NA
35	Methyl methacrylate	ND		ND
37	Methylacrylonitrile	ND		ND
38	Methylene chloride	ND		ND
230	2-Nitropropane	NA		NA
39	Pyridine	ND		ND
40	1,1,1,2-Tetrachloroethane	ND		ND
41	1,1,2,2-Tetrachloroethane	ND		ND
42	Tetrachloroethene	ND		ND
43	Toluene	5.4 - 26		ND
44	Tribromomethane	ND		ND
45	1,1,1-Trichloroethane	ND		ND
46	1,1,2-Trichloroethane	ND		ND
47	Trichloroethene	ND		ND
48	Trichloromonofluromethane	ND		ND
49	1,2,3-Trichloropropane	ND		ND
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA		NA
50	Vinyl chloride	ND		ND
215	1,2-Xylene	NA		NA
216	1,3-Xylene	NA		NA
217	1,4-Xylene	NA		NA
	Total Xylenes	<1.5 - 5.3		ND
	Semivolatiles			
51	Acenaphthalene	ND		ND
52	Acenaphthene	ND		ND
53	Acetophenone	ND		ND
54	2-Acetylaminofluorene	ND		ND
55	4-Aminobiphenyl	ND		ND
56	Aniline	ND		ND
57	Anthracene	ND		ND
58	Aramite	NA		NA
59	Benz(a)anthracene	ND		ND
218	Benzal chloride	NA		NA
60	Benzenethiol	ND		ND
61	Benzidine	ND		ND
62	Benzo(a)pyrene	ND		ND

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a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 to 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste [a] (Continued)

	Parameter	Untreated K102 Detection Status (mg/kg)	Untreated K102 Believed to be Present	Scrubber Wastewater (mg/l)
	Semivolatiles (continued)			
63	Benzo(b)fluoranthene	ND		ND
64	Benzo(ghi)perylene	ND		ND
65	Benzo(k)fluoranthene	ND		ND
66	p-Benzoquinone	ND		ND
67	Bis(2-chloroethoxy)ethane	ND		ND
68	Bis(2-chloroethyl)ether	ND		ND
69	Bis(2-chloroisopropy)ether	ND		ND
70	Bis(2-ethylhexyl)phthalate	ND		<0.010 - 0.031
71	4-Bromophenyl phenyl ether	ND		ND
72	Butyl benzyl phthlate	ND		ND
73	2-sec-Butyl-4,6-dinitrophenol	ND		ND
74	p-Chloroaniline	ND		ND
75	Chlorobenzilate	NA		NA
76	p-Chloro-m-cresol	ND		ND
77	2-Chloronaphthalene	ND		ND
78	2-Chlorophenol	ND		ND
79	3-Chloropropionitrile	NA		NA
80	Chrysene	ND		ND
81	ortho-Cresol	ND		ND
82	para-Cresol	ND		ND
232	Cyclohexanone	ND		ND
83	Dibenz(a,h)anthracene	ND		ND
84	Dibenzo(a,e)pyrene	NA		NA
85	Dibenzo(a,i)pyrene	NA		NA
86	m-Dichlorobenzene	ND		ND
87	o-Dichlorobenzene	ND		ND
88	p-Dichlorobenzene	ND		ND
89	3,3'-Dichlorobenzidine	ND		ND
90	2,4-Dichlorophenol	ND		ND
91	2,6-Dichlorophenol	ND		ND
92	Diethyl phthalate	ND		ND
93	3,3'-Dimethyoxlbenzidine	ND		ND
94	p-Dimethylaminoazobenzene	ND		ND
95	3,3'-Dimethylbenzidine	ND		ND
96	2,4-Dimethylphenol	ND		ND
97	Dimethyl phthalate	ND		ND
98	Di-n-butyl phthalate	ND		ND
99	1,4-Dinitrobenzene	ND		ND
100	4,6-Dinitro-o-cresol	ND		ND
101	2,4-Dinitrophenol	ND		ND

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a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 to 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste[a] (Continued)

	Parameter	Untreated K102		Scrubber Wastewater (mg/l)
		Detection Status (mg/kg)	Believed to be Present	
	Semivolatiles (cont.)			
102	2,4-Dinitrotoluene	ND		ND
103	2,6-Dinitrotoluene	ND		ND
104	Di-n-octyl phthalate	ND		ND
105	Di-n-propylnitrosamine	ND		ND
106	Diphenylamine	ND		ND
219	Diphenylnitrosamine	NA		ND
107	1,2-Diphenylhydrazine	ND		NA
108	Fluoranthene	ND		ND
109	Fluorene	ND		ND
110	Hexachlorobenzene	ND		ND
111	Hexachlorobutadiene	ND		ND
112	Hexachlorocyclopentadiene	ND		ND
113	Hexachloroethane	ND		ND
114	Hexachlorophene	NA		ND
115	Hexachloropropene	ND		NA
116	Indeno(1,2,3-cd)pyrene	ND		ND
117	Isosafrole	ND		ND
118	Methapyrilene	NA		ND
119	3-Methycholanthrene	ND		NA
120	4,4'-Methylenebis(2-chloroaniline)	ND		ND
36	Methyl methanesulfonate	ND		ND
121	Napthalene	ND		ND
122	1,4-Naphthoquinone	NA		ND
123	1-Napthylamine	ND		NA
124	2-Napthylamine	ND		ND
125	p-Nitroaniline	ND		ND
126	Nitrobenzene	ND		ND
***	2-Nitrophenol	220 - 870		ND
127	4-Nitrophenol	ND		ND
128	N-Nitrosodi-n-butylamine	ND		ND
129	N-Nitrosodiethylamine	ND		ND
130	N-Nitrosodimethylamine	ND		ND
131	N-Nitrosomethylethylamine	ND		ND
132	N-Nitrosomorpholine	ND		ND
133	N-Nitrosopiperidine	ND		ND
134	N-Nitrosopyrrolidine	ND		ND
135	5-Nitro-o-toluidine	ND		ND
136	Pentachlorobenzene	ND		ND
137	Pentachloroethane	NA		ND
138	Pentachloronitrobenzene	ND		NA

***- Not on BDAT List.

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 to 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste [a] (Continued)

	Parameter	Untreated K102 Detection Status (mg/kg)	Untreated K102 Believed to be Present	Scrubber Wastewater (mg/l)
	Semivolatiles (cont.)			
139	Pentachlorophenol	ND		ND
140	Phenacetin	ND		ND
141	Phenanthrene	ND		ND
142	Phenol	ND		<0.010 - 0.023
220	Phthalic anhydride	ND		ND
143	2-Picoline	ND		ND
144	Pronamide	ND		ND
145	Pyrene	ND		ND
146	Resorcinol	NA		NA
147	Safrole	ND		ND
148	1,2,4,5-Tetrachlorobenzene	ND		ND
149	2,3,4,6-Tetrachlorophenol	ND		ND
150	1,2,4-Trichlorobenzene	ND		ND
151	2,4,5-Trichlorophenol	ND		ND
152	2,4,6-Trichlorophenol	ND		ND
153	Tris(2,3-dibromopropyl)phosphate	ND		ND
	Metals			
154	Antimony	203 - 1990		291 - 712
155	Arsenic	633 - 1080		341 - 713
156	Barium	15 - 39		0.198 - 0.648
157	Beryllium	<0.1		<0.001 - 0.002
158	Cadmium	<0.5 - 4.2		0.283 - 2.8
159	Chromium	12 - 42		0.372 - 0.606
221	Chromium (hexavalent)	ND		ND
160	Copper	8.7 - 46		1.12 - 1.619
161	Lead	<0.5 -11		<0.005 - 0.567
162	Mercury	<0.1 - 0.12		0.018 - 0.053
163	Nickel	9.1 - 76		0.018 - 0.228
164	Selenium	6.7 - 13		0.119 - 0.413
165	Silver	ND		0.007 - 0.016
166	Thallium	<1.0 - <5.0		0.246 - 0.562
167	Vanadium	0.73 - 4.3		0.023 - 0.04
168	Zinc	2.3 - 24		1.230 - 1.850
	Inorganics			
169	Cyanide	<1.0		ND
170	Fluoride	<2.02**		<2.02**
171	Sulfide	6.4 - 8.7		6.4 - 8.7

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a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 to 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

** - Indicates that only sample set 3 was analyzed for this constituent.

Continued

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste [a] (Continued)

	Parameter	Untreated K102		Scrubber Wastewater (mg/l)
		Detection Status (mg/kg)	Believed to be Present	
	Organochlorine Pesticides			
172	Aldrin	NA		NA
173	alpha-BHC	NA		NA
174	beta-BHC	NA		NA
175	delta-BHC	NA		NA
176	gamma-BHC	NA		NA
177	Chlordane	NA		NA
178	DDD	NA		NA
179	DDE	NA		NA
180	DDT	NA		NA
181	Dieldrin	NA		NA
182	Endosulfan I	NA		NA
183	Endosulfan II	NA		NA
184	Endrin	NA		NA
185	Endrin aldehyde	NA		NA
186	Heptachlor	NA		NA
187	Heptachlor epoxide	NA		NA
188	Isodrin	NA		NA
189	Kepone	NA		NA
190	Mehoxychlor	NA		NA
191	Toxaphene	NA		NA
	Phenoxyacetic Acid Herbicides			
192	2,4-Dichlorophenoxyacetic acid	NA		NA
193	Silvex	NA		NA
194	2,4,5-T	NA		NA
	Organophosphorous Insecticides			
195	Disulfoton	NA		NA
196	Famphur	NA		NA
197	Methyl parathion	NA		NA
198	Paration	NA		NA
199	Phorate	NA		NA
	PCBs**			
200	Aroclor 1016	ND		ND
201	Aroclor 1221	ND		ND
202	Aroclor 1232	ND		ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 to 5-9.
NA - This constituent was not analyzed.
ND - This constituent was not detected.

Continued

TABLE 6-2 BDAT List Constituents in Untreated K102 Waste [a] (Continued)

	Parameter	Untreated K102 Detection Status (mg/kg)	Untreated K102 Believed to be Present	Scrubber Wastewater (mg/l)
	PCBs** (continued)			
203	Aroclor 1242	ND		ND
204	Aroclor 1248	ND		ND
205	Aroclor 1254	ND		ND
206	Aroclor 1260	ND		ND
	Dioxins and Furans**			
207	Hexachlorodibenzo-p-dioxins	ND		ND
208	Hexachlorodibenzofuran	ND		ND
209	Pentachlorodibenzo-p-dioxins	ND		ND
210	Pentachlorodibenzofuran	ND		ND
211	Tetrachlorodibenzo-p-dioxins	ND		ND
212	Tetrachlorodibenzofuran	ND		ND
213	2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND		ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-2 through 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

As shown in Table 6-2, the following constituents were detected in the untreated waste K102: toluene, 2-nitrophenol, total xylenes, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, vanadium, zinc, cyanide, fluoride, and sulfide. The following constituents were detected in the kiln ash after incineration of in the K102 waste: antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, fluoride, and sulfide.

The following constituents were detected in the scrubber waters generated from incineration: bis(2-ethylhexyl) phthalate, phenol, antimony, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

Some constituents that were not detected in the untreated waste were detected in the ash and scrubber water. Organic constituents detected in the scrubber water but not detected in the untreated waste had detection limits considerably lower than in the untreated waste. Metal constituents that were detected in the treated waste but were not detected or were lower in concentrations than in the untreated waste may be present because of lower detection limits or operating conditions of the kiln. This is the case for both K101 and K102.

The untreated and treated waste samples were not analyzed for other classes of BDAT organics (organochlorine pesticides, phenoxyacetic acid herbicides, and organophosphorous pesticides) both because there is no in-process source of these constituents and because it is extremely unlikely that these constituents would be found at treatable levels in the waste.

6.2 Constituents Detected in the Untreated Waste But Not Considered for Regulation

Some BDAT metal constituents, such as beryllium, mercury, selenium, silver, thallium, and vanadium, which were detected in the untreated waste, were not present at treatable levels in the kiln ash for K101 and K102 waste codes. Therefore, these metals were not selected as regulated constituents for kiln ash nonwastewaters of K101 and K102.

Metal constituents present in K101 and K102 scrubber water that were not selected for regulation in the wastewaters are as follows: barium, beryllium, chromium, copper, nickel, selenium, silver, thallium, vanadium, and zinc. These metals were not selected because they were not present at treatable levels in the scrubber water.

Although copper and zinc were present at treatable levels in nonwastewaters, the Agency believes that these metal constituents are effectively controlled by treatment of the metal constituents that are regulated by today's rule. Therefore, the Agency is not promulgating standards for copper and zinc as part of the treatment standards for K101/K102 nonwastewaters.

The nonmetallic inorganic constituents were generally present in untreatable concentrations in the untreated waste codes K101 and K102. Also, by comparing the concentration of cyanide and fluoride in the untreated and treated waste for both waste codes, the Agency concluded that these two constituents were not substantially treated. The Agency recognizes that the sulfide concentration was diminished in the treated waste, but considers this an incidental treatment since the treatment technology tested is not demonstrated for the treatment of sulfides. As a result, the BDAT list inorganic constituents (other than metals) in K101 and K102 were eliminated as a class of BDAT list constituents to be regulated in waste codes K101 and K102.

The remaining two classes of constituents, namely, volatiles and semivolatiles, were generally present at treatable concentration levels in the untreated waste. Volatiles and semivolatiles were judged to be substantially treated by incineration. Only bis(2-ethylhexyl)phthalate was not considered for regulation since it is believed to be a contaminant because of sample containerization.

Tables 6-3 and 6-4 list the constituents considered for regulation by class and waste form. The selection of constituents is presented below.

6.3 Constituents Selected for Regulation

The Agency evaluated the analytical data for each constituent to determine whether that constituent should be selected for regulation. In general, the Agency was guided by the criteria for selecting regulated constituents as described in Section 1 of this background document. Table 6-5 lists the constituents selected for regulation by class. The rationale for selecting the regulated constituents is presented below.

TABLE 6-3 Constituents Considered for Regulation in K101

Constituent	Nonwastewaters	Wastewaters
Volatile Organics		
Acetone	X	X
Toluene	X	X
Semivolatile Organics		
2-Nitroaniline	X	X
Metals		
Antimony	X	X
Arsenic	X	X
Barium	X	
Cadmium	X	X
Chromium	X	
Copper	X	
Lead	X	X
Mercury		X
Nickel	X	
Zinc	X	

TABLE 6-4 Constituents Considered for Regulation in K102

Constituent	Nonwastewaters	Wastewaters
Volatile Organics		
Toluene	X	X
Total Xylenes	X	X
Semivolatile Organics		
2-Nitrophenol	X	X
Phenol	X	X
Metals		
Antimony	X	X
Arsenic	X	X
Barium	X	
Cadmium	X	X
Chromium	X	
Copper	X	
Lead	X	X
Mercury		X
Nickel	X	
Zinc	X	

TABLE 6-5 Constituents Selected for Regulation in K101/K102

Constituent	Nonwastewaters	Wastewaters
Semivolatile Organics		
2-Nitroaniline[a]	X	X
2-Nitrophenol[b]	X	X
Metals		
Antimony	X	X
Arsenic	X	X
Barium	X	
Cadmium	X	X
Chromium	X	
Copper		
Lead	X	X
Mercury		X
Nickel	X	
Zinc		

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[a] Regulated only in K101.

[b] Regulated only in K102.

6.3.1 Nonwastewaters

(1) Volatile and semivolatile organics. The non-BDAT constituent 2-nitroaniline was present in significant concentrations in untreated K101. It was substantially treated by incineration. Therefore, 2-nitroaniline was selected as a regulated constituent for K101 organic nonwastewaters. This constituent was also selected because it will indicate whether or not the treatment system has substantially reduced organic constituent concentrations in K101. The boiling point of 2-nitroaniline is 284°C, higher than the other organic constituents present in untreated K101. Therefore, if 2-nitroaniline is effectively treated by incineration, then other organics present in K101 are also effectively treated.

Acetone and toluene were present at moderate levels in untreated K101, but were not detected in the treated waste. The boiling points of acetone and toluene are 56.2°C and 110.6°C, respectively, which are considerably lower than that of 2-nitroaniline. The Agency also considers the detection limits for aniline in untreated K101 waste to be unusually high and believes aniline was present at moderate levels. The boiling point of aniline is 184 to 186°C. Therefore, if 2-nitroaniline is effectively treated, then acetone, toluene, and aniline will also be treated. As a result, acetone, toluene, and aniline will not be proposed for regulation at this time. However, treatment standards have been developed, as described in Section 7.

The constituent selected for regulation in K102 as the indicator for the destruction of organics present in the waste is 2-nitrophenol. The non-BDAT constituent 2-nitrophenol was detected in treatable concentrations in untreated K102, but was not detected in the treated waste. The boiling point of 2-nitrophenol is 216°C, which is higher than the boiling points of other organic constituents present in untreated K102. Therefore, the effective treatment of 2-nitrophenol will indicate that organics present in untreated K102 have also been effectively treated.

Toluene and xylenes were detected at moderate levels in untreated K102. The boiling points of ortho-, meta-, and para-xylenes are 144.4, 139.1, and 138.3°C, respectively. Toluene and xylenes will not be selected for regulation because if 2-nitrophenol is effectively treated, then toluene and xylenes will also be treated.

(2) Metals. Incineration is not an applicable or demonstrated treatment of BDAT list metals. The incinerator ash and scrubber water generated by the incineration process contain treatable concentration levels for several metal constituents. The EPA did not collect data for the stabilization of the BDAT list metals for K101 and K102. However, nonwastewaters with similar constituents and characteristics have been effectively treated by metals stabilization. Therefore, metals stabilization is believed to effectively treat the metal constituents in K101 and K102 nonwastewaters.

Selection of metal constituents to be regulated in K101 and K102 is dependent upon the concentration of the metals in the incinerator ash. For the purposes of transferring data, the incinerator ash is considered the untreated waste and the performance data that are transferred are considered the treated waste. The K101 and K102 metals concentrations in the ash must be compared to data for the waste codes that are being considered for transferring data. Only constituents present and at treatable levels will be considered for regulation. After a comparison with several nonwastewaters, F006 metals stabilization data were transferred to K101 and K102.

Arsenic, antimony, and barium will not be regulated in the K101 and K102 nonwastewaters at this time. The Agency is investigating other treatment techniques for these three metals. For K101 and K102 kiln ash nonwastewaters, the other metals present in the kiln ash at treatable levels for metals stabilization are cadmium, chromium, copper, lead, nickel, and zinc. However, in this rulemaking the Agency is only regulating zinc and copper when they are indicators of performance of treatment for other Appendix VIII of 40 CFR Part 261 constituents. Further, the Agency believes that these metals are effectively controlled by treatment of the metal constituents that are regulated by today's rule and therefore is not promulgating standards for copper or zinc as part of the treatment standards for K101/K102 nonwastewaters. The Agency also believes that the metals stabilization of the kiln ash will effectively reduce the leachability of the metal constituents present in the nonwastewaters.

6.3.2 Wastewaters

(1) Volatile and semivolatile organics. The two organic indicators, 2-nitroaniline and 2-nitrophenol, selected for K101 and K102 nonwastewaters, respectively, were also selected for the wastewater forms of K101 and K102. The rationale for their selection is the same as the one discussed for K101 and K102 nonwastewaters. If 2-nitroaniline and 2-nitrophenol are effectively treated by incineration, then other organics present in the waste will also be reduced to acceptable concentration levels.

(2) Metals. Antimony, arsenic, cadmium, lead, and mercury were present at treatable levels in the scrubber water for treatment by chemical precipitation. The Agency believes that chemical precipitation of the scrubber water for K101 and K102 will effectively treat the metals present at treatable concentrations. As a result, the five metals listed above were selected as regulated constituents for waste codes K101 and K102 wastewaters. At this time the treatment standard for antimony will be deferred until a suitable waste code has been selected for the transference of data.

7. CALCULATION OF TREATMENT STANDARDS

In this section, the actual treatment standards for waste codes K101 and K102 are presented. These standards were calculated based on the performance of the demonstrated treatment system that was determined by the Agency to be the best for treating both waste codes. In Section 5, BDAT for the listed waste codes K101 and K102 was determined to be rotary kiln incineration, followed by stabilization of the resulting ash, and chemical precipitation of the scrubber water, followed by stabilization of the resulting precipitate. The previous section identified the constituents proposed for regulation for the nonwastewater and wastewater forms of K101 and K102 wastes.

As discussed in Section 1, the Agency calculated the BDAT treatment standards for waste codes K101 and K102 by following a four-step procedure: (1) editing the data; (2) correcting the remaining data for analytical interference; (3) calculating adjustment factors (variability factors) to account for process variability; and (4) calculating the actual treatment standards using variability factors and average treatment values. The four steps in this procedure are discussed in detail in Sections 7.1 through 7.4.

7.1 Editing the Data

7.1.1 Nonwastewaters

Four sets of treatment data for waste code K101 and six sets of treatment data for waste code K102 were collected by the Agency from a treatment system consisting of rotary kiln incineration. Three samples of the treated K101 waste were collected at the end of the performance test and were analyzed. Four samples of treated K102 waste were collected during the performance test and were analyzed. The Agency evaluated the seven data sets to determine whether the treatment system was well operated at the time of the sampling visit. None of the data sets were eliminated on the basis of this evaluation.

The performance data used for evaluating metals stabilization were transferred from F006 and are shown in Section 4.

7.1.2 Wastewaters

Five data sets were collected by the Agency from a treatment system consisting of chemical precipitation for D004. The performance data were transferred to the wastewaters in K101 and K102 based upon waste characteristics affecting performance. The Agency evaluated the five data sets to determine whether the treatment system was well operated at the time of the engineering visit. None of the data sets were eliminated on the basis of this evaluation.

7.2 Correcting the Remaining Data

All data values were corrected to take into account analytical interferences associated with the chemical makeup of the treated sample. This correction was accomplished by calculating an accuracy factor from the percent recoveries for the selected regulated constituents in K101 and K102. The actual recovery values and accuracy factors for the selected constituents are presented in Appendix B. The corrected concentration values for K101 and K102 nonwastewaters are shown in Tables 7-1 and 7-2. The corrected concentration values for K101 and K102 wastewaters are shown in Table 7-3. The corrected concentration values were obtained by multiplying the accuracy factors by the concentration values in the treated waste. Arithmetic average values, representing the treated waste concentration, were calculated for all constituents in K101 and K102 from the corrected concentrations.

7.3 Calculating Variability Factors

It is expected that in normal operation of a well-designed and well-operated treatment system there will be some variability in performance. Based on the test data, a measure of this variability is expressed by the variability factor. The methodology for calculating variability factors is explained in Appendix A of this report. Tables 7-1 through 7-3 present the results of calculations for the selected constituents in nonwastewaters and wastewaters. Appendix D of this report shows how the actual values in Tables 7-1 through 7-3 were calculated.

In instances where a selected constituent was not detected in the treated waste, the treated value for that constituent was assumed to be the detection limits. For example, both 2-nitroaniline in K101 and 2-nitrophenol in K102 were not detected in the incinerator ash or the scrubber water, and concentration values for the incinerator ash and scrubber water were set at their detection limits. This resulted in no apparent variation among the treated values and a calculated variability

Table 7-1 Regulated Constituents and Calculated Treatment Standards for Organics in K101 and K102 Nonwastewaters [a]

BDAT Constituent	Accuracy-Corrected Concentration (mg/kg)				Average Treated Waste Concentration (mg/kg)	Variability Factor (VF)	Treatment Standard (mg/kg) (Average x VF)
	Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4			
K101 REGULATED CONSTITUENTS							
Volatile							
*Acetone [1]	0.010	0.010	0.010	---	0.010	2.80	0.028
*Toluene	0.005	0.005	0.005	---	0.005	2.80	0.014
Semivolatile							
*Aniline [2]	1.050	1.050	1.050	---	1.050	2.80	2.9
*** 2-Nitroaniline [2]	5.000	5.000	5.000	---	5.000	2.80	14
K102 REGULATED CONSTITUENTS							
Volatile							
*Toluene	1.500	1.500	1.500	1.500	1.500	2.80	4.2
*Total Xylenes [1]	1.500	1.500	1.500	1.500	1.500	2.80	4.2
Semivolatile							
*** 2-Nitrophenol [3]	4.760	4.760	4.760	4.760	4.760	2.80	13
*Phenol	1.640	1.640	1.640	1.640	1.640	2.80	4.6

a - Accuracy Correction Factors and Variability Factors were determined as discussed in Appendix A.

* - Not proposed for regulation.

*** - Not on BDAT List.

1 - The average percent recovery for volatiles was used in the calculation of the this standard.

2 - The average percent recovery for semivolatiles was used in the calculation of the this standard.

3 - Percent recovery of 4-Nitrophenol was used in the calculation of the standard for 2-Nitrophenol.

Table 7-2 Regulated Constituents and Calculated Treatment Standards for Inorganics in F006 Nonwastewaters

	Accuracy Corrected Constituents Concentrations in Treated Leachate (mg/l)						
	Antimony	Arsenic	Barium	Cadmium	Chromium	Lead	Nickel
				-	-	-	0.04
				0.01	0.46	0.39	0.03
				0.06	0.09	0.34	0.26
				0.01	-	0.23	0.02
				0.01	0.35	0.37	0.03
				0.01	0.44	0.39	0.04
				0.01	1.4	0.41	0.11
				0.01	-	0.40	0.04
				-	-	0.29	0.02
Average concentration				0.017	0.55	0.35	0.066
Variability factor				3.9	6.9	1.5	4.7
Treatment standard	**	**	**	0.066	3.8	0.53	0.31

** - Deferred for proposed regulation until later date.

Table 7-3 Regulated Constituents and Calculated Treatment Standards for K101 and K102 Wastewaters

BDAT Constituent	Accuracy-Corrected Concentration (mg/l) Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4	Sample Set #5	Sample Set #6	Average Treated Waste Concentration (mg/l)	Variability Factor (VF)	Treatment Standard (mg/l) (Average x VF)
Semivolatiles									
***2-Nitroaniline *[1]	0.095	0.095	0.095	0.095	---	---	0.095	2.80	0.27
***2-Nitrophenol *[2]	0.010	0.010	0.010	0.010	0.010	0.010	0.010	2.80	0.028
Metals [3]									
Antimony									**
Arsenic	0.291	1.400	0.359	0.293	0.308	---	0.530	3.842	2.0
Cadmium	0.085	0.085	0.085	0.085	0.085	---	0.085	2.80	0.24
Lead	0.006	0.035	0.030	0.012	0.030	---	0.023	4.783	0.11
Mercury	0.001	0.004	0.009	0.004	0.006	---	0.005	5.400	0.027

* - 2-Nitroaniline is proposed for regulation in K101 only. 2-Nitrophenol is proposed for regulation in K102 only.

** - Deferred for proposed regulation until later date.

*** - Not on BDAT List.

1 - The average percent recovery of all semivolatiles was used in the calculation of the standard for 2-Nitroaniline.

2 - Percent recovery of 4-Nitrophenol was used in the calculation of the standard for 2-Nitrophenol.

3 - Performance data for metals were transferred from D004 (see Section 5 of the Onsite Engineering Report for D004).

factor of 1.0. A variability factor of 1.0 represents test data from a process measured without variation and analytical interferences. Instead of using the calculated value of 1.0, the variability factors for 2-nitroaniline and 2-nitrophenol were fixed at 2.8 as justified in Appendix A of this document.

7.4 Calculating the Treatment Standards

The treatment standards for the selected constituents were calculated by multiplying the variability factors by the average concentration values for the treated waste. The treatment standards for K101/K102 nonwastewaters are presented in Tables 7-1 and 7-2. The treatment standards for K101/K102 wastewaters are presented in Table 7-3.

7.4.1 Nonwastewaters

No performance data were available for the treatment of metals in K101 and K102 nonwastewaters. The Agency, therefore, decided to transfer performance data from the treatment of wastes that were determined to be similar to K101 and K102 nonwastewaters based on waste characteristics affecting performance. The nonwastewater performance data for K101 and K102 were transferred from treatment data for EPA hazardous waste code F006. Table 7-2 provides treatment standards for proposed regulated constituents in F006. The concentrations of metals in the untreated F006 waste were compared to metal concentrations in K101/K102 nonwastewaters. Data from F006 were transferred on a metal-specific basis, provided the concentration of metal in the untreated F006 was greater than in the untreated K101 and K102. In this manner performance data were transferred for four out of nine proposed metals in K101 and K102 nonwastewaters. These metals are as follows: cadmium, chromium, lead, and nickel. Performance data for the three deferred metals, antimony, arsenic, and barium, were not transferred from F006 either because the constituents existed at much higher concentrations in the untreated K101 and K102 nonwastewaters than in untreated F006 nonwastewater or because F006 performance data did not show significant treatment. The Agency is investigating other treatment techniques for these three metals, and is reserving the antimony, arsenic, and barium standards for a future date.

The BDAT nonwastewater treatment standards for waste code K101 and K102 are as follows:

Constituent	Total composition (mg/kg)	TCLP (mg/l)
2-Nitroaniline[a]	14	NA
2-Nitrophenol[b]	13	NA
Antimony	NA	deferred
Arsenic	NA	deferred
Barium	NA	deferred
Cadmium	NA	0.066
Chromium	NA	5.2
Lead	NA	0.51
Nickel	NA	0.32

NA = Not applicable
[a] Regulated in K101 only.
[b] Regulated in K102 only.

The Agency has also calculated treatment standards for BDAT list organics that are present in untreated K101 in lower concentrations than

2-nitroaniline, and in untreated K102 that are present at lower concentrations than 2-nitrophenol (see Table 7-1). These calculated standards are as follows:

Organic constituent	Treatment standard K101 (mg/kg)	 K102 (mg/kg)
Acetone	0.028	NR
Toluene	0.014	4.2
Aniline	2.9	NR
Total Xylenes	NR	4.2
Phenol	NR	4.6

NR = Not regulated since it is not present at treatable levels.

If the Agency considers regulating BDAT list organics that are present in untreated K101 and K102 at lower concentration levels than 2-nitroaniline and 2-nitrophenol, then acetone, toluene, and aniline in K101, and toluene, total xylenes, and phenol in K102 would be the constituents under consideration.

7.4.2 Wastewaters

No performance data were available for the treatment of K101 and K102 wastewaters. The Agency, therefore, decided to transfer performance data from the treatment of wastes that were determined to be similar to K101 and K102 wastewaters based on waste characteristics affecting performance. The wastewater performance data for waste codes K101 and K102 were transferred from treatment data for D004. Table 7-3 provides treatment standards for proposed regulated metals in D004. The concentrations of metals in the untreated characteristic waste D004 and K101/K102 wastewaters were compared, and performance data from D004 were transferred to K101 and K102 on a metal-specific basis, provided the concentration of the metal in the untreated characteristic waste D004 was greater than in untreated K101 and K102. In this manner, performance data were transferred for four of the five proposed metals in K101 and K102 wastewaters, namely, arsenic, cadmium, lead, and mercury. Performance data for antimony, the other regulated metal in K101 and K102 wastewaters, were not transferred from D004 because antimony existed at a much higher concentration in the untreated K101 and K102 wastewaters than in untreated D004 wastewaters. (See the Onsite Engineering Report for Salsbury Laboratories for D004). Therefore, the Agency reserves the antimony standard for a future date.

The BDAT wastewater treatment standards for K101 and K102 are as follows:

Constituent	Total composition (mg/l)
2-Nitroaniline[a]	0.27
2-Nitrophenol[b]	0.028
Antimony	deferred
Arsenic	2.0
Cadmium	0.24
Lead	0.11
Mercury	0.027

[a] Regulated in K101 only.
[b] Regulated in K102 only.

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APPENDIX A

STATISTICAL METHODS

A.1 F Value Determination for ANOVA Test

As noted in Section 1.2, EPA is using the statistical method known as analysis of variance (ANOVA) to determine the level of performance that represents "best" treatment where more than one technology is demonstrated. This method provides a measure of the differences between data sets.

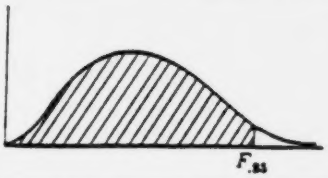
If the Agency found that the levels of performance for one or more technologies are not statistically different (i.e., the data sets are homogeneous), EPA would average the long-term performance values achieved by each technology and then multiply this value by the largest variability factor associated with any of the acceptable technologies. If EPA found that one technology performs significantly better (i.e., the data sets are not homogeneous), the "best" technology would be the technology that achieves the best level of performance, i.e., the technology with the lowest mean value.

To determine whether any or all of the treatment performance data sets are homogeneous using the analysis of variance method, it is necessary to compare a calculated "F value" to what is known as a "critical value." (See Table A-1.) These critical values are available in most statistics texts (see, for example, Statistical Concepts and Methods by Bhattacharyya and Johnson, 1977, John Wiley Publications, New York).

Table A-1

95th PERCENTILE VALUES FOR THE *F* DISTRIBUTION

n_1 = degrees of freedom for numerator
n_2 = degrees of freedom for denominator
(shaded area = .95)



n_2 \ n_1	1	2	3	4	5	6	8	12	16	20	30	40	50	100	∞
1	161.4	199.5	215.7	224.6	230.2	234.0	238.9	243.9	246.3	248.0	250.1	251.1	252.2	253.0	254.3
2	18.51	19.00	19.16	19.25	19.30	19.33	19.37	19.41	19.43	19.45	19.46	19.46	19.47	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.85	8.74	8.69	8.66	8.62	8.60	8.58	8.56	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.04	5.91	5.84	5.80	5.75	5.71	5.70	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.82	4.68	4.60	4.56	4.50	4.46	4.44	4.40	4.36
6	5.99	5.14	4.76	4.53	4.39	4.28	4.15	4.00	3.92	3.87	3.81	3.77	3.75	3.71	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.73	3.57	3.49	3.44	3.38	3.34	3.32	3.28	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.44	3.28	3.20	3.15	3.08	3.05	3.03	2.98	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.23	3.07	2.98	2.93	2.86	2.82	2.80	2.76	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.07	2.91	2.82	2.77	2.70	2.67	2.64	2.59	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	2.95	2.79	2.70	2.65	2.57	2.53	2.50	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.85	2.69	2.60	2.54	2.46	2.42	2.40	2.35	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.77	2.60	2.51	2.46	2.38	2.34	2.32	2.26	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.70	2.53	2.44	2.39	2.31	2.27	2.24	2.19	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.64	2.48	2.39	2.33	2.25	2.21	2.18	2.12	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.59	2.42	2.33	2.28	2.20	2.16	2.13	2.07	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.55	2.38	2.29	2.23	2.15	2.11	2.08	2.02	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.51	2.34	2.25	2.19	2.11	2.07	2.04	1.98	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.48	2.31	2.21	2.15	2.07	2.02	2.00	1.94	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.45	2.28	2.18	2.12	2.04	1.99	1.96	1.90	1.84
22	4.30	3.44	3.05	2.82	2.66	2.55	2.40	2.23	2.13	2.07	1.98	1.93	1.91	1.84	1.78
24	4.26	3.40	3.01	2.78	2.62	2.51	2.36	2.18	2.09	2.03	1.94	1.89	1.86	1.80	1.73
26	4.23	3.37	2.98	2.74	2.59	2.47	2.32	2.15	2.05	1.99	1.90	1.85	1.82	1.76	1.69
28	4.20	3.34	2.95	2.71	2.56	2.45	2.29	2.12	2.02	1.96	1.87	1.81	1.78	1.72	1.65
30	4.17	3.32	2.92	2.69	2.53	2.42	2.27	2.09	1.99	1.93	1.84	1.79	1.76	1.69	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.18	2.00	1.90	1.84	1.74	1.69	1.66	1.59	1.51
50	4.03	3.18	2.79	2.56	2.40	2.29	2.13	1.95	1.85	1.78	1.69	1.63	1.60	1.52	1.44
60	4.00	3.15	2.76	2.53	2.37	2.25	2.10	1.92	1.81	1.75	1.65	1.59	1.56	1.48	1.39
70	3.98	3.13	2.74	2.50	2.35	2.23	2.07	1.89	1.79	1.72	1.62	1.56	1.53	1.45	1.35
80	3.96	3.11	2.72	2.48	2.33	2.21	2.05	1.88	1.77	1.70	1.60	1.54	1.51	1.42	1.32
100	3.94	3.09	2.70	2.46	2.30	2.19	2.03	1.85	1.75	1.68	1.57	1.51	1.48	1.39	1.28
150	3.91	3.06	2.67	2.43	2.27	2.16	2.00	1.82	1.71	1.64	1.54	1.47	1.44	1.34	1.22
200	3.89	3.04	2.65	2.41	2.26	2.14	1.98	1.80	1.69	1.62	1.52	1.45	1.42	1.32	1.19
400	3.86	3.02	2.62	2.39	2.23	2.12	1.96	1.78	1.67	1.60	1.49	1.42	1.38	1.28	1.13
∞	3.84	2.99	2.60	2.37	2.21	2.09	1.94	1.75	1.64	1.57	1.46	1.40	1.32	1.24	1.00

Where the F value is less than the critical value, all treatment data sets are homogeneous. If the F value exceeds the critical value, it is necessary to perform a "pair wise F" test to determine if any of the sets are homogeneous. The "pair wise F" test must be done for all of the various combinations of data sets using the same method and equation as the general F test.

The F value is calculated as follows:

(i) All data are natural logtransformed.

(ii) The sum of the data points for each data set is computed (T_i).

(iii) The statistical parameter known as the sum of the squares between data sets (SSB) is computed:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right) \right] - \left[\frac{\left(\sum_{i=1}^{k} T_i \right)^2}{N} \right]$$

where:

k = number of treatment technologies
n_i = number of data points for technology i
N = number of data points for all technologies
T_i = sum of natural logtransformed data points for each technology.

(iv) The sum of the squares within data sets (SSW) is computed:

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2{}_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right)$$

where:

$x_{i,j}$ = the natural logtransformed observations (j) for treatment technology (i).

(v) The degrees of freedom corresponding to SSB and SSW are calculated. For SSB, the degree of freedom is given by k-1. For SSW, the degree of freedom is given by N-k.

(vi) Using the above parameters, the F value is calculated as follows:

$$F = \frac{MSB}{MSW}$$

where:

MSB = SSB/(k-1) and
MSW = SSW/(N-k).

A computational table summarizing the above parameters is shown below.

Computational Table for the F Value

Source	Degrees of freedom	Sum of squares	Mean square	F value
Between	k-1	SSB	MSB = SSB/k-1	MSB/MSW
Within	N-k	SSW	MSW = SSW/N-k	

Below are three examples of the ANOVA calculation. The first two represent treatment by different technologies that achieve statistically similar treatment; the last example represents a case in which one technology achieves significantly better treatment than the other technology.

Example 1
Methylene Chloride

	Steam stripping				Biological treatment		
Influent (µg/l)	Effluent (µg/l)	ln(effluent)	$[\ln(\text{effluent})]^2$	Influent (µg/l)	Effluent (µg/l)	ln(effluent)	$[\ln(\text{effluent})]^2$
1550.00	10.00	2.30	5.29	1960.00	10.00	2.30	5.29
1290.00	10.00	2.30	5.29	2568.00	10.00	2.30	5.29
1640.00	10.00	2.30	5.29	1817.00	10.00	2.30	5.29
5100.00	12.00	2.48	6.15	1640.00	26.00	3.26	10.63
1450.00	10.00	2.30	5.29	3907.00	10.00	2.30	5.29
4600.00	10.00	2.30	5.29				
1760.00	10.00	2.30	5.29				
2400.00	10.00	2.30	5.29				
4800.00	10.00	2.30	5.29				
12100.00	10.00	2.30	5.29				
Sum:							
-	-	23.18	53.76	-	-	12.46	31.79
Sample Size:							
10	10	10	-	5	5	5	
Mean:							
3669	10.2	2.32	-	2378	13.2	2.49	-
Standard Deviation:							
3328.67	.63	.06	-	923.04	7.15	.43	-
Variability Factor:							
	1.15	-	-	-	2.48	-	-

ANOVA Calculations:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right) \right] - \left[\frac{\left(\sum_{i=1}^{k} T_i \right)^2}{N} \right]$$

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

Example 1 (Continued)

$F = MSB/MSW$

where:

k = number of treatment technologies

n_i = number of data points for technology i

N = number of natural logtransformed data points for all technologies

T_i = sum of logtransformed data points for each technology

X_{ij} = the nat. logtransformed observations (j) for treatment technology (i)

$n_1 = 10,\ n_2 = 5,\ N = 15,\ k = 2,\ T_1 = 23.18,\ T_2 = 12.46,\ T = 35.64,\ T^2 = 1270.21$

$T_1^2 = 537.31 \quad T_2^2 = 155.25$

$$SSB = \left(\frac{537.31}{10} + \frac{155.25}{5}\right) - \frac{1270.21}{15} = 0.10$$

$$SSW = (53.76 + 31.79) - \left(\frac{537.31}{10} + \frac{155.25}{5}\right) = 0.77$$

$MSB = 0.10/1 = 0.10$

$MSW = 0.77/13 = 0.06$

$$F = \frac{0.10}{0.06} = 1.67$$

ANOVA Table

Source	Degrees of freedom	SS	MS	F value
Between(B)	1	0.10	0.10	1.67
Within(W)	13	0.77	0.06	

The critical value of the F test at the 0.05 significance level is 4.67. Since the F value is less than the critical value, the means are not significantly different (i.e., they are homogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

Example 2
Trichloroethylene

Steam stripping				Biological treatment			
Influent ($\mu g/l$)	Effluent ($\mu g/l$)	ln(effluent)	$[\ln(\text{effluent})]^2$	Influent ($\mu g/l$)	Effluent ($\mu g/l$)	ln(effluent)	$[\ln(\text{effluent})]^2$
1650.00	10.00	2.30	5.29	200.00	10.00	2.30	5.29
5200.00	10.00	2.30	5.29	224.00	10.00	2.30	5.29
5000.00	10.00	2.30	5.29	134.00	10.00	2.30	5.29
1720.00	10.00	2.30	5.29	150.00	10.00	2.30	5.29
1560.00	10.00	2.30	5.29	484.00	16.25	2.79	7.78
10300.00	10.00	2.30	5.29	163.00	10.00	2.30	5.29
210.00	10.00	2.30	5.29	182.00	10.00	2.30	5.29
1600.00	27.00	3.30	10.89				
204.00	85.00	4.44	19.71				
160.00	10.00	2.30	5.29				
Sum:							
-	-	26.14	72.92	-	-	16.59	39.52
Sample Size:							
10	10	10	-	7	7	7	-
Mean:							
2760	19.2	2.61	-	220	10.89	2.37	-
Standard Deviation:							
3209.6	23.7	.71	-	120.5	2.36	.19	-
Variability Factor:							
-	3.70	-	-	-	1.53	-	-

ANOVA Calculations:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i^{\,2}}{n_i} \right) \right] - \left[\frac{\left(\sum_{i=1}^{k} T_i \right)^2}{N} \right]$$

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2{}_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i{}^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

Example 2 (Continued)

$F = MSB/MSW$

where:

k = number of treatment technologies

n_i = number of data points for technology i

N = number of data points for all technologies

T_i = sum of natural logtransformed data points for each technology

X_{ij} = the natural logtransformed observations (j) for treatment technology (i)

$N_1 = 10$, $N_2 = 7$, $N = 17$, $k = 2$, $T_1 = 26.14$, $T_2 = 16.59$, $T = 42.73$, $T^2 = 1825.85$, $T_1^2 = 683.30$,

$T_2^2 = 275.23$

$$SSB = \left(\frac{683.30}{10} + \frac{275.23}{7}\right) - \frac{1825.85}{17} = 0.25$$

$$SSW = (72.92 + 39.52) - \left(\frac{683.30}{10} + \frac{275.23}{7}\right) = 4.79$$

$MSB = 0.25/1 = 0.25$

$MSW = 4.79/15 = 0.32$

$$F = \frac{0.25}{0.32} = 0.78$$

ANOVA Table

Source	Degrees of freedom	SS	MS	F value
Between(B)	1	0.25	0.25	0.78
Within(W)	15	4.79	0.32	

The critical value of the F test at the 0.05 significance level is 4.54. Since the F value is less than the critical value, the means are not significantly different (i.e., they are homogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

Example 3
Chlorobenzene

Activated sludge followed by carbon adsorption				Biological treatment			
Influent (µg/l)	Effluent (µg/l)	ln(effluent)	[ln(effluent)]^2	Influent (µg/l)	Effluent (µg/l)	ln(effluent)	ln[(effluent)]^2
7200.00	80.00	4.38	19.18	9206.00	1083.00	6.99	48.86
6500.00	70.00	4.25	18.06	16646.00	709.50	6.56	43.03
6075.00	35.00	3.56	12.67	49775.00	460.00	6.13	37.58
3040.00	10.00	2.30	5.29	14731.00	142.00	4.96	24.60
				3159.00	603.00	6.40	40.96
				6756.00	153.00	5.03	25.30
				3040.00	17.00	2.83	8.01
Sum:							
-	-	14.49	55.20	-	-	38.90	228.34
Sample Size:							
4	4	4	-	7	7	7	-
Mean:							
5703	49	3.62	-	14759	452.5	5.56	-
Standard Deviation:							
1835.4	32.24	.95		16311.86	379.04	1.42	
Variability Factor:							
-	7.00	-	-	-	15.79	-	-

ANOVA Calculations:

$$SSB = \left[\sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right) \right] - \left[\frac{\left(\sum_{i=1}^{k} T_i \right)^2}{N} \right]$$

$$SSW = \left[\sum_{i=1}^{k} \sum_{j=1}^{n_i} x^2_{i,j} \right] - \sum_{i=1}^{k} \left(\frac{T_i^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

$$F = MSB/MSW$$

Example 3 (Continued)

where,

k = number of treatment technologies

n_i - number of data points for technology i

N = number of data points for all technologies

T_i = sum of natural logtransformed data points for each technology

X_{ij} - the natural logtransformed observations (j) for treatment technology (i)

$N_1 = 4,\ N_2 = 7,\ N = 11,\ k = 2,\ T_1 = 14.49,\ T_2 = 38.90,\ T = 53.39,\ T^2 = 2850.49,\ T_1^2 = 209.96$

$T_2^2 - 1513.21$

$$SSB - \left(\frac{209.96}{4} + \frac{1513.21}{7}\right) - \frac{2850.49}{11} \quad - 9.52$$

$$SSW = (55.20 + 228.34) - \left(\frac{209.96}{4} + \frac{1513.21}{7}\right) \quad = 14.88$$

MSB = 9.52/1 = 9.52

MSW = 14.88/9 = 1.65

F = 9.52/1.65 = 5.77

ANOVA Table

Source	Degrees of freedom	SS	MS	F value
Between(B)	1	9.53	9.53	5.77
Within(W)	9	14.89	1.65	

The critical value of the F test at the 0.05 significance level is 5.12. Since the F value is larger than the critical value, the means are significantly different (i.e., they are heterogeneous). Activated sludge followed by carbon adsorption is "best" in this example because the mean of the long-term performance value, i.e., the effluent concentration, is lower.

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

A.2 Variability Factor

$$VF = \frac{C_{99}}{Mean}$$

where:

VF = estimate of daily maximum variability factor determined from a sample population of daily data;

C_{99} = estimate of performance values for which 99 percent of the daily observations will be below. C_{99} is calculated using the following equation: $C_{99} = Exp(y + 2.33\ Sy)$ where y and Sy are the mean and standard deviation, respectively, of the logtransformed data; and

Mean = average of the individual performance values.

EPA is establishing this figure as an instantaneous maximum because the Agency believes that on a day-to-day basis the waste should meet the applicable treatment standards. In addition, establishing this requirement makes it easier to check compliance on a single day. The 99th percentile is appropriate because it accounts for almost all process variability.

In several cases, all the results from analysis of the residuals from BDAT treatment are found at concentrations less than the detection limit. In such cases, all the actual concentration values are considered unknown and, hence, cannot be used to estimate the variability factor of the analytical results. Below is a description of EPA's approach for calculating the variability factor for such cases with all concentrations below the detection limit.

It has been postulated as a general rule that a lognormal distribution adequately describes the variation among concentrations. Agency data show that the treatment residual concentrations are distributed approximately lognormally. Therefore, the lognormal model has been used routinely in the EPA development of numerous regulations in the Effluent Guidelines program and is being used in the BDAT program. The variability factor (VF) was defined as the ratio of the 99th percentile (C_{99}) of the lognormal distribution to its arithmetic mean (Mean), as follows:

$$VF = \frac{C_{99}}{Mean}. \qquad (1)$$

The relationship between the parameters of the lognormal distribution and the parameters of the normal distribution created by taking the natural logarithms of the lognormally distributed concentrations can be found in most mathematical statistics texts (see, for example, Distribution in Statistics-Volume 1 by Johnson and Kotz, 1970). The mean of the lognormal distribution can be expressed in terms of the mean (μ) and standard deviation (σ) of the normal distribution as follows:

$$C_{99} = \text{Exp}\ (\mu + 2.33\sigma) \qquad (2)$$

$$\text{Mean} = \text{Exp}\ (\mu + 0.5\sigma^2). \qquad (3)$$

By substituting (2) and (3) in (1), the variability factor can then be expressed in terms of σ as follows:

$$\mathbf{VF} = \text{Exp}\ (2.33\ \sigma - 0.5\sigma^2). \qquad (4)$$

For residuals with concentrations that are not all below the detection limit, the 99th percentile and the mean can be estimated from the actual analytical data and, accordingly, the variability factor (VF) can be estimated using equation (1). For residuals with concentrations that are below the detection limit, the above equations can be used in conjunction with the following assumptions to develop a variability factor.

- Assumption 1: The actual concentrations follow a lognormal distribution. The upper limit (UL) is equal to the detection limit. The lower limit (LL) is assumed to be equal to one-tenth of the detection limit. This assumption is based on the fact that data from well-designed and well-operated treatment systems generally fall within one order of magnitude.
- Assumption 2: The natural logarithms of the concentrations have a normal distribution with an upper limit equal to ln (UL) and a lower limit equal to ln (LL).
- Assumption 3: The standard deviation (σ) of the normal distribution is approximated by:

$$\begin{aligned}\sigma &= [\ln(UL) - \ln(LL)] / [(2)(2.33)] \\ &= [\ln(UL/LL)] / 4.66. \qquad (5)\end{aligned}$$

(Note that when $LL = (0.1)(UL)$ as in Assumption 1, then $\sigma = (\ln 10) / 4.66 = 0.494$.)

Substitution of the σ value from equation (5) into equation (4) yields the variability factor, VF, as shown:

$$VF = 2.8. \qquad (6)$$

APPENDIX B

ANALYTICAL QUALITY ASSURANCE/QUALITY CONTROL

The analytical methods used for analysis of the regulated constituents identified in Section 5 are listed in Table B-1. SW-846 methods (EPA's Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, SW-846, Third Edition, November 1986) are used in most cases for determining total waste concentrations.

Deviations from SW-846 methods required to analyze the sample matrix are listed in Table B-2. These deviations are approved methods for determining constituent concentrations. SW-846 also allows for the use of alternative or equivalent procedures or equipment; these are described in Tables B-3 through B-6. These alternatives or equivalents included use of alternative sample preparation methods and/or use of different extraction techniques to reduce sample matrix interferences.

The accuracy determination for a constituent is based on the matrix spike recovery values. Table B-7 presents the matrix spike recovery values for total waste concentrations of 2-nitroaniline and 2-nitrophenol for K101 and K102, respectively, for the EPA-collected data. Because 2-nitroaniline matrix spike recoveries were not collected, the average of the percent recoveries equal to or greater than 20 percent for all semivolatiles was used as the percent recovery for 2-nitroaniline. Since matrix spike recoveries for 2-nitrophenol were not available, the percent recoveries for the isomer 4-nitrophenol were used.

The accuracy-correction factors for the regulated constituents for the treatment residuals are presented in Table B-7 through B-9. The accuracy-correction factors were determined in accordance with the general methodology presented in the Introduction. For example, for 2-nitroaniline, the average of the actual spike recovery data for all semivolatiles obtained for the analysis of liquid matrices and the lowest average percent recovery value was used to calculate the accuracy-correction factor. An example of the calculation of the corrected concentration value for 2-nitroaniline is shown below.

Analytical value	Average % recovery	Correction factor	Corrected value
2.0 mg/kg	40	$\frac{100}{40} = 2.50$	2.50 x 2.0 mg/kg = 5.000 mg/kg

Table B-1 Analytical Methods for Regulated Constituents

Regulated Constituent	Analytical Method	Method Number	Reference
Semivolatiles			
2-Nitroaniline 2-Nitrophenol	Continuous Liquid/Liquid Extraction	3520	1
	Soxhlet Extraction	3540	1
	Gas Chromatography/Mass Spectrometry Column Technique	8270	1
Metals			
Antimony Arsenic Barium Cadmium Chromium Copper Nickel Zinc	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption Spectroscopy (AA) or Inductivity Coupled Plasma Atomic Emission Spectroscopy (ICP)	3010	1
	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Furnace Atomic Absorption Spectroscopy (AA)	3020	1
	Acid Digestion of Sediments, Sludges, and Soils	3050	1
	Acid Digestion for Metals	3060	2
	Inductively Coupled Plasma Atomic Emission Spectroscopy	6010	1
Lead	Lead (AA, Furnace Technique)	7421	1
Mercury	Mercury in Liquid Waste (Manual Cold-Vapor Technique)	7471	1
Selenium	Selenium (AA, Furnace Technique)	7740	1

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1 - Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste. Third Edition. U. S. EPA. Office of Solid Waste and Emergency Response. November 1986.

2 - Environmental Protection Agency. 1982. Test Methods for Evaluating Solid Waste. Second Edition. U. S. EPA. Office of Solid Waste and Emergency Response. September 1982.

Table B-2 Deviations from SW-846[a]

Analysis	Method	SW-846 specifications	Deviation from SW-846	Rationale for deviation
1. Acid Digestion for metals analyzed	3010 3020	Digest 100 ml of sample in a conical beaker.	Initial sample volume of 59 ml is digested in Griffin straight-side beakers. All acids and peroxides are halved.	Sample volume and reagents are reduced in half; therefore, time required to reduce sample to near dryness is reduced. However, this procedures produces no impact on the precision and accuracy of the data.
2. Selenium Digestion	7740	Pipet 5 ml of digested solution into 10 ml volumetric flask; add 1 ml of the 1% nickel nitrate solution and dilute to 10 ml with Type II water. An aliquot is then injected into the instrument.	Digestate is brought to original volume and the nickel nitrate solution is added at the time of analysis. One ml of sample digestate and standards have 0.02 ml of 5% $NiNO_3$ solution added to them.	This procedure reduces time required to complete dilution procedure and produces no impact on the precision and accuracy of the data. This procedure also allows the laboratory to store only the concentrated digestates.

a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-6.

Table B-3 Specific Procedures or Equipment Used in Extraction of Organic Compounds When Alternatives or Equivalents are Allowed in the SW-846 Methods[a]

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Purge and Trap	5030	5 milliliters of liquid 1 gram of solid	• The purge and trap device to be used is specified in the method in Figure 1, the desorber to be used is described in Figures 2 and 3, and the packing materials are described in Section 4.10.2. The method allows equivalents of this equipment or materials to be used.	• The purge and trap equipment and the desorber used were as specified in SW-846. The purge and trap equipment is a Teckmar LSC-2 with standard purging chambers (Supelco cat. 2-0293). The packing materials for the traps were 1/3 silica gel and 2/3 2,6-diphenylene.
			• The method specifies that the trap must be at least 25 cm long and have an inside diameter of at least 0.105 cm.	• The length of the trap was 30 cm and the diameter was 0.105 cm.
			• The surrogates recommended are toluene-d8,4-bromofluorobenzene, and 1,2-dichloroethane-d4. The recommended concentration level is 50 µg/l.	• The surrogates were added as specified in SW-846.
Continuous Liquid-Liquid Extraction	3520	1 liter of liquid	• Acid and base/neutral extracts are usually combined before analysis by GC/MS. Under some situations, however, they may be extracted and analyzed separately.	• Acid and base/neutral extracts were combined.
			• The base/neutral surrogates recommended are 2-fluorobiphenyl, nitrobenzene-d5, terphenyl-d14. The acid surrogates recommended are 2-fluorophenol, 2,4,6-tribromophenol, and phenol-d6. Additional compounds	• Surrogates were the same as those recommended by SW-846, with the exception that phenol-d5 was substituted for phenol-d6. The concentrations used were the concentrations recommended in SW-846.

Table B-3 (Continued)

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Continuous Liquid-Liquid Extraction (Continued)			may be used for surrogates. The recommended concentrations for low-medium concentration level samples are 100 ppm for acid surrogates and 200 ppm for base/neutral surrogates. Volume of surrogate may be adjusted.	
Soxhlet Extraction	3540	1 gram of solid	• The recommended surrogates and their concentrations are the same as for Method 3520. • Sample grinding may be required for sample not passing through a 1 mm standard sieve or a 1 mm opening.	• The surrogates used and their concentration levels are the same as for Method 3520. • Sample grinding was not required.

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a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-7.

Table B-4 Specific Procedures or Equipment Used in Extraction of Organic Compounds When Alternatives to SW-846 Methods Are Allowed by Approval of EPA Characterization and Assessment Division[a]

Analysis	SW-846 Method	Sample Aliquot	SW-846 Specification	Specific Procedures Allowed by Approval of EPA-CAD
Continuous Liquid/ Liquid Extraction or Soxhlet Extraction	3520 3540	1 liter or 1 gram	• The internal standards are prepared by dissolution in carbon disulfide and then diluting to such volume that the final solvent is 20% carbon disulfide and 80% methylene chloride.	• The preparation of the internal standards was changed to eliminate the use of carbon disulfide. The internal standards were prepared in methylene chloride only.

a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-5.

Table B-5 Special Procedures or Equipment Used for Analysis of Organic Compounds When Alternatives or Equivalents are Allowed in the SW-846 Methods[a]

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure	Specific equipment or procedures used
Gas Chromatography/ Mass Spectrometry for volatile organics	8240	5030	• Recommended GC/MS operating conditions: Electron energy: 70 ev (nominal) Mass range: 35-260 amu Scan time: To give 5 scans/peak but not to exceed 7 sec/scan Initial column temperature: 45°C Initial column holding time: 3 min Column temperature program: 8°C/min Final column temperature: 200°C Final column holding time: 15 min Injector temperature: 200-225°C Source temperature: According to manufacturer's specification Transfer line temperature: 250-300°C Carrier gas: Hydrogen at 50 cm/sec or helium at 30 cm/sec • The column should be 6 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh) or an equivalent. • Samples may be analyzed by purge and trap technique or by direct injection.	• Actual GC/MS operating conditions: Electron energy: 70 ev Mass range: 35-260 amu Scan time: 2.5 sec/scan Initial column temperature: 30°C Initial column holding time: 2 min Column temperature program: 10°C/min Final column temperature: 225°C Final column holding time: 30 min or xylene elutes Injector temperature: 225°C Source temperature: Manufacturer's recommended value of 100°C Transfer line temperature: 275°C Carrier gas: Helium @ 30 ml/min • Additional Information on Actual System Used: Equipment: Finnegan model 5100 GC/MS/DS system Data:system SUPERINCOS Autoquan Mode: Electron Impact NBS library available Interface to MS - Jet separator • The column used was an 8 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh). • The samples were analyzed using the purge and trap technique.

Table B-5 (Continued)

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure	Specific equipment or procedures used
Gas Chromatography/ Mass Spectrometry for semivolatile organics: capillary column technique	8270	3520-liquids 3520-solids	• Recommended GC/MS operating conditions: Mass range: 35-500 amu Scan time: 1 sec/scan Initial column temperature: 40°C Initial column holding time: 4 min Column temperature program: 40-270°C at 10°C/min Final column temperature hold: 270°C (until benzo[g,h,i,]perylene has eluted) Injector temperature: 250-300°C Transfer line temperature: 250-300°C Source temperature: According to manufacturer's specification Injector: Grob-type, splitless Sample volume: 1-2 µl Carrier gas: Hydrogen at 50 cm/sec or helium at 30 cm/sec • The column should be 30 m by 0.25 mm I.D., 1-µm film thickness silicon-coated fused silica capillary column (J&W Scientific DB-5 or equivalent).	• Actual GC/MS operating conditions: Mass range: 35-500 amu Scan time: 1 sec/scan Initial column temperature: 30°C Initial column holding time: 4 min Column temperature program: 8°C/min to 275° and 10°C/min until 305°C Final column temperature hold: 305°C Injector temperature: 240-260°C Transfer line temperature: 300°C Source temperature: Manufacturer's recommendation (non-heated) Injector: Grob-type, spitless Sample volume: 1 µl of sample extract Carrier gas: Helium @ 40 cm/sec • Additional Information on Actual System Used: Equipment: Finnegan Model 5 00 GC/MS/DS system Software Package: SUPERINCOS AUTOQUAN • The column used was a 30 m x 0.32 mm I.D. RT_x -5 (5% phenyl methyl silicone) FSCC.

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a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-8.

Table B-6 Specific Procedures or Equipment Used in Preparation for Analysis of Metals When Alternatives or Equivalents are Allowed in the SW-846 Methods[a]

Analysis	SW-846 method	Equipment	Alternative or equivalent allowed by SW 846 methods	Specific procedures or equipment used
Inductively coupled plasma atomic emission spectroscopy	6010	Jarrell Ash 1140	• Operate equipment following instructions provided by instrument's manufacturer.	• Equipment operated using procedures specified in the Jarrell Ash (JA) 1140 Operator's Manual.
			• For operation with organic solvents, auxiliary argon gas inlet is recommended.	• Auxiliary argon gas was not required for sample matrix.
Metals by Furnace AA			• Operate equipment following instructions provided by instrument's manufacturer.	• Equipment operated using procedures specified in (1) the Perkin Elmer 3030 Instruction Manual, (2) the Perkin Elmer Model 5000 Instruction Manual, and (3) the Perkin Elmer 2580 Instruction Manual.
Thallium	7841	(1) Perkin Elmer 3030		
Selenium	7740	(2) Perkin Elmer 5000 #1		
Lead	7421	(3) Perkin Elmer 5000 #2		
		(4) Perkin Elmer 2580		
			• For background correction, use either continuous correction or alternatives, e.g., Zeeman correction.	• Background detection was used. Continuous correction on Models 2380 and 5000 #2 and Zeeman on Model 3030 and 5000 #1.
			• If samples contain a large amount of organic material, they should be oxidized by conventional acid digestion before being analyzed.	• Samples were prepared using acid digestion procedures from SW-846.

Table B-6 (Continued)

Analysis	SW-846 method	Equipment	Alternative or equivalent allowed by SW-846 methods	Specific procedures or equipment used
Mercury	7471	Perkin Elmer 50A	• Operate equipment following instructions provided by instrument's manufacturer.	• Equipment operated using procedures specified in the Perkin Elmer 50A Instructions Manual.
			• Cold vapor apparatus is described in SW-846, or an equivalent apparatus may be used	• Mercury was analyzed by cold vapor method using the apparatus as specified in SW-846 except there was no scrubber.
			• Sample may be prepared using the water bath method or the autoclave method described in SW-846.	• Samples were prepared using the water bath method.

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a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-9.

Table B-7 Matrix Spike Recoveries for Kiln Ash [a]

BDAT Constituent	Original Amount Found (ug/L)	Sample Set[+]			Sample Set Duplicate[+]			Accuracy Factor**
		Spike Added (ug/L)	Spike Result (ug/L)	Percent Recovery*	Spike Added (ug/L)	Spike Result (ug/L)	Percent Recovery*	
Semivolatile								
*** 2-Nitroaniline++	---	---	---	41	---	---	40	2.50
*** 2-Nitrophenol+++	ND	200	43	22	200	42	21	4.76

a - From Onsite Engineering Report of John Zink Company, Tulsa, Oklahoma for K101 and K102. Table 6-16.

*Percent Recovery = [(Spike Result - Original Amount)/Spike Amount)] x 100.
**Accuracy Correction Factor = 100/(Percent Recovery), using the lower of the two percent recovery values.

ND = Not detected. Value assumed to be zero in calculation for percent recovery.

*** = Not on BDAT List.

+ = For the matrix spike recoveries presented: Semivolatiles from Sample Set 3.

++ = The matrix spike recovery values presented for 2-nitroaniline are actually the average of the percent recoveries greater than 20% for all semivolatiles.

+++ = The matrix spike recovery values presented for 2-nitrophenol are actually for the isomer 4-nitrophenol.

Table B-8 Matrix Spike Recoveries for Treated D004 Waste [a]

BDAT Constituent	Original Amount Found (ug/l)	Sample Set 1			Sample Set Duplicate 1			Accuracy** Factor
		Spike Added (ug/l)	Spike Result (ug/l)	Percent* Recovery	Spike Added (ug/l)	Spike Result (ug/l)	Percent* Recovery	
Metals								
155. Arsenic	782	2000	3640	143	2000	3980	160	0.70
158. Cadmium	<80	500	484	97	500	471	94	1.06
161. Lead	<5	25	21	84	25	37	148	1.19
162. Mercury	0.86	5	5.6	95	5	5.6	95	1.05

a - Obtained from Onsite Engineering Report for D004. Table 6-14.

* - Percent Recovery = [(Spike Result - Original Amount)/Spike Amount)] x 100.

** - Accuracy Correction Factor = 100/(Percent Recovery), using the lower of the two percent recovery values.

Table B-9 Matrix Spike Recoveries for Treated F006 Waste [a]

BDAT Constituent	Original Amount Found (ppm)	Duplicate (ppm)	Actual Spike (ppm)	Percent Recovery	Accuracy Correction Factor *
155. Arsenic	0.101**	0.01	0.086	94.5	1.06
	0.01***	0.01	0.068	104.0	0.96
156. Barium	0.3737	0.3326	4.9474	91.9	1.09
	0.2765	0.222	5.1462	97.9	1.02
158. Cadmium	0.0075	0.0069	4.9010	97.9	1.02
	2.9034	0.7555	6.5448	94.3	1.06
159. Chromium	0.3494	0.4226	4.6780	85.8	1.17
	0.2213	0.2653	4.5709	86.6	1.15
160. Copper	0.2247	0.2211	4.8494	92.5	1.08
	0.1526	0.1462	4.9981	97.0	1.03
161. Lead	0.3226	0.3091	4.9619	92.9	1.08
	0.2142	0.2287	4.6930	89.4	1.12
162. Mercury	0.001	0.001	0.0034	92.0	1.09
	0.001	0.001	0.0045	110.0	0.91
163. Nickel	0.028	0.0264	4.5400	90.3	1.11
	0.4742	0.0859	4.6093	86.6	1.15
164. Selenium****	0.101	0.12	0.175	86.0	1.16
	0.043	0.053	0.095	66.0	0.96
168. Zinc	0.0133	0.0238	5.0910	101.4	0.99
	27.202	3.65	19.818	87.8	1.14

a - Obtained from the Background Document for F006. Table 6-1.
* - Accuracy Correction Factor = 100/(Percent Recovery).
** - At a mix ratio of 0.5.
*** - At a mix ratio of 0.2.
**** - For a mix ratio of 0.2, correction factor of 1.16 was used when correcting for selenium concentrations.

APPENDIX C

DETECTION LIMITS FOR K101 and K102

Table C-1 through C-10 show detection limits for samples collected during the K101 and K102 test burn.

TABLE C-1 DETECTION LIMITS FOR K101 BACKGROUND SCRUBBER WATER, BACKGROUND QUENCH WATER, AND FINAL QUENCH WATER

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Volatile Organics			
222	Acetone	0.010	0.010	0.010
1	Acetonitrile	0.100	0.100	0.100
2	Acrolein	0.100	0.100	0.100
3	Acrylonitrile	0.100	0.100	0.100
4	Benzene	0.005	0.005	0.005
5	Bromodichloromethane	0.005	0.005	0.005
6	Bromomethane	0.010	0.010	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	0.005	0.005	0.005
8	Carbon Disulfide	0.005	0.005	0.005
9	Chlorobenzene	0.005	0.005	0.005
10	2-Chloro-1,3-Butadiene	0.100	0.100	0.100
11	Chlorodibromomethane	0.005	0.005	0.005
12	Chloroethane	0.010	0.010	0.010
13	2-Chloroethylvinylether	0.010	0.010	0.010
14	Chloroform	0.005	0.005	0.005
15	Chloromethane	0.010	0.010	0.010
16	3-Chloropropene	0.100	0.100	0.100
17	1,2-Dibromo-3-Chloropropane	0.010	0.010	0.010
18	1,2-Dibromoethane	0.005	0.005	0.005
19	Dibromomethane	0.005	0.005	0.005
20	Trans-1,4-Dichloro-2-Butene	0.100	0.100	0.100
21	Dichlorodifluoromethane	0.010	0.010	0.010
22	1,1-Dichloroethane	0.005	0.005	0.005
23	1,2-Dichloroethane	0.005	0.005	0.005
24	1,1-Dichloroethene	0.005	0.005	0.005
25	Trans-1,2-Dichloroethene	0.005	0.005	0.005
26	1,2-Dichloropropane	0.005	0.005	0.005
27	Trans-1,3-Dichloropropene	0.005	0.005	0.005
28	cis-1,3,Dichloropropene	0.005	0.005	0.005
29	1,4-Dioxane	0.200	0.200	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	0.005	0.005	0.005
30	Ethyl Cyanide	0.100	0.100	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	0.100	0.100	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	0.050	0.050	0.050
33	Isobutyl Alcohol	0.200	0.200	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	0.010	0.010	0.010
34	Methyl ethyl ketone	0.010	0.010	0.010
229	Methyl isobutyl ketone	0.010	0.010	0.010
35	Methyl Methacrylate	0.100	0.100	0.100

TABLE C-1 (Continued)

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	0.100	0.100	0.100
38	Methylene Chloride	0.005	0.005	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	0.400	0.400	0.400
	Styrene	0.005	0.005	0.005
40	1,1,1,2-Tetrachloroethane	0.005	0.005	0.005
41	1,1,2,2-Tetrachloroethane	0.005	0.005	0.005
42	Tetrachloroethene	0.005	0.005	0.005
43	Toluene	0.005	0.005	0.005
44	Tribromomethane(bromoform)	0.005	0.005	0.005
45	1,1,1-Trichloroethane	0.005	0.005	0.005
46	1,1,2-Trichloroethane	0.005	0.005	0.005
47	Trichloroethene	0.005	0.005	0.005
48	Trichloromonofluoromethane	0.005	0.005	0.005
49	1,2,3-Trichloropropane	0.005	0.005	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	0.010	0.010	0.010
50	Vinyl Chloride	0.010	0.010	0.010
	Xylenes	0.005	0.005	0.005
	Semivolatile Organics			
51	Acenaphthalene	0.010	0.010	0.010
52	Acenaphthene	0.010	0.010	0.010
53	Acetophenone	0.020	0.020	0.020
54	2-Acetylaminofluorene	0.020	0.020	0.020
55	4-Aminobiphenyl	0.020	0.020	0.020
56	Aniline	0.010	0.010	0.010
57	Anthracene	0.010	0.010	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	0.010	0.010	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	0.050	0.050	0.050
	Benzoic Acid	0.010	0.010	0.010
62	Benzo(a)pyrene	0.010	0.010	0.010
63	Benzo(b)fluoranthene	0.010	0.010	0.010
64	Benzo(g,h,i) perylene	0.010	0.010	0.010
65	Benzo(k)fluoranthene	0.010	0.010	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	0.010	0.010	0.010
67	Bis(2-Chloroethoxy) methane	0.010	0.010	0.010
68	Bis(2-Chloroethyl) Ether	0.010	0.010	0.010
69	Bis(2-chloroisopropyl) ether	0.010	0.010	0.010
70	Bis(2-ethylhexyl) phthalate	0.010	0.010	0.010
71	4-Bromophenyl phenyl ether	0.010	0.010	0.010

TABLE C-1 (Continued)

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	0.010	0.010	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	0.050	0.050	0.050
74	p-Chloroaniline	0.010	0.010	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	0.010	0.010	0.010
77	2-Chloronaphthalene	0.010	0.010	0.010
78	2-Chlorophenol	0.010	0.010	0.010
	4-Chlorophenyl-phenyl ether	0.010	0.010	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	0.010	0.010	0.010
81	Ortho-cresol	0.010	0.010	0.010
82	para-cresol	0.010	0.010	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	0.010	0.010	0.010
	Dibenzofuran	0.010	0.010	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	0.010	0.010	0.010
87	1,2-Dichlorobenzene	0.010	0.010	0.010
88	1,4-Dichlorobenzene	0.010	0.010	0.010
89	3,3'Dichlorobenzidine	0.020	0.020	0.020
90	2,4-Dichlorophenol	0.010	0.010	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	0.010	0.010	0.010
93	3,3'-Dimethoxybenzidine	0.010	0.010	0.010
94	p-Dimethylaminoazobenzene	0.020	0.020	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	0.010	0.010	0.010
97	Dimethyl Phthalate	0.010	0.010	0.010
98	Di-n-butyl phthalate	0.010	0.010	0.010
99	1,4-Dinitrobenzene	0.050	0.050	0.050
100	4,6-dinitro-o-cresol	0.050	0.050	0.050
101	2,4-Dinitrophenol	0.050	0.050	0.050
102	2,4-Dinitrotoluene	0.010	0.010	0.010
103	2,6-Dinitrotoluene	0.010	0.010	0.010
104	Di-n-octyl phthalate	0.010	0.010	0.010
105	Di-n-propylnitrosoamine	0.010	0.010	0.010
106	Diphenylamine (1)	0.020	0.020	0.020
107	1,2,-Diphenylhydrazine	0.050	0.050	0.050
108	Fluoranthene	0.010	0.010	0.010
109	Fluorene	0.010	0.010	0.010
110	Hexachlorobenzene	0.010	0.010	0.010
111	Hexachlorobutadiene	0.010	0.010	0.010
112	Hexachlorocyclopentadiene	0.010	0.010	0.010
113	Hexachloroethane	0.010	0.010	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-1 (Continued)

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	0.010	0.010	0.010
117	Isosafrole	0.020	0.020	0.020
	Isophorone	0.010	0.010	0.010
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	0.020	0.020	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	0.020	0.020	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methyl naphthalene	0.010	0.010	0.010
121	Naphthalene	0.010	0.010	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	0.050	0.050	0.050
124	2-Naphthylamine	0.050	0.050	0.050
	2-Nitroaniline	0.050	0.050	0.050
	3-Nitroaniline	0.050	0.050	0.050
125	p-Nitroaniline	0.050	0.050	0.050
126	Nitrobenzene	0.010	0.010	0.010
	2-Nitrophenol	0.010	0.010	0.010
127	4-Nitrophenol	0.050	0.050	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	0.010	0.010	0.010
131	N-Nitrosomethylethylamine	0.010	0.010	0.010
132	N-Nitrosomorpholine	0.020	0.020	0.020
219	N-Nitrosodiphenylamine (1)	0.010	0.010	0.010
133	1-Nitrosopiperidine	0.010	0.010	0.010
134	N-Nitrosopyrrolidine	0.050	0.050	0.050
135	2-Methyl-5-nitroaniline	0.020	0.020	0.020
136	Pentachlorobenzene	ND	ND	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	0.100	0.100	0.100
139	Pentachlorophenol	0.050	0.050	0.050
140	Phenacetin	0.020	0.020	0.020
141	Phenanthrene	0.010	0.010	0.010
142	Phenol	0.010	0.010	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	0.010	0.010	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	0.010	0.010	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	0.050	0.050	0.050
148	1,2,4,5-Tetrachlorobenzene	0.020	0.020	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	0.010	0.010	0.010
151	2,4,5-Trichlorophenol	0.050	0.050	0.050
152	2,4,6-Trichlorophenol	0.010	0.010	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-1 (Continued)

	BOAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Metals - Total Composition			
154	Antimony	0.330	0.033	0.033
155	Arsenic	0.280	0.028	0.028
156	Barium	0.002	0.002	0.002
157	Beryllium	0.001	0.001	0.001
158	Cadmium	0.050	0.050	0.005
159	Chromium	0.004	0.004	0.004
221	Hexavalent Chromium	0.010	0.010	0.010
160	Copper	0.005	0.005	0.005
161	Lead	1.250	0.050	0.005
162	Mercury	0.002	0.0002	0.0002
163	Nickel	0.011	0.011	0.011
164	Selenium	0.250	0.050	0.005
165	Silver	0.007	0.007	0.007
166	Thallium	0.100	0.010	0.010
167	Vanadium	0.004	0.004	0.004
168	Zinc	0.004	0.004	0.004
	Metals - TCLP			
154	Antimony			
155	Arsenic			
156	Barium			
157	Beryllium	NOT		
158	Cadmium			
159	Chromium			
160	Copper		ANALYZED	
161	Lead			
162	Mercury			
163	Nickel			
164	Selenium			
165	Silver			
166	Thallium			
167	Vanadium			
168	Zinc			
	Inorganics			
169	Cyanide	0.010	0.010	0.010
170	Flouride	0.2	0.2	0.2
171	Sulfide	0.5	0.5	0.5
	Other Parameters			
	Chlorides	1	1	1
	Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-2 DETECTION LIMITS FOR K101 SAMPLE SET #1

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics			
222	Acetone	50	0.010	0.010
1	Acetonitrile	500	0.100	0.100
2	Acrolein	500	0.100	0.100
3	Acrylonitrile	500	0.100	0.100
4	Benzene	25	0.005	0.005
5	Bromodichloromethane	25	0.005	0.005
6	Bromomethane	50	0.010	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	25	0.005	0.005
8	Carbon Disulfide	25	0.005	0.005
9	Chlorobenzene	25	0.005	0.005
10	2-Chloro-1,3-Butadiene	500	0.100	0.100
11	Chlorodibromomethane	25	0.005	0.005
12	Chloroethane	50	0.010	0.010
13	2-Chloroethylvinyletner	50	0.010	0.010
14	Chloroform	25	0.005	0.005
15	Chloromethane	50	0.010	0.010
16	3-Chloropropene	500	0.100	0.100
17	1,2-Dibromo-3-Chloropropane	50	0.010	0.010
18	1,2-Dibromoethane	25	0.005	0.005
19	Dibromomethane	25	0.005	0.005
20	Trans-1,4-Dichloro-2-Butene	500	0.100	0.100
21	Dichlorodifluoromethane	50	0.010	0.010
22	1,1-Dichloroethane	25	0.005	0.005
23	1,2-Dichloroethane	25	0.005	0.005
24	1,1-Dichloroethene	25	0.005	0.005
25	Trans-1,2-Dichloroethene	25	0.005	0.005
26	1,2-Dichloropropane	25	0.005	0.005
27	Trans-1,3-Dichloropropene	25	0.005	0.005
28	cis-1,3,Dichloropropene	25	0.005	0.005
29	1,4-Dioxane	1000	0.200	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	25	0.005	0.005
30	Ethyl Cyanide	500	0.100	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl-Methacrylate	500	0.100	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	250	0.050	0.050
33	Isobutyl Alcohol	1000	0.200	0.200
	Methyl butyl ketone	50	0.010	0.010
34	Methyl ethyl ketone	50	0.010	0.010
229	Methyl isobutyl ketone	50	0.010	0.010
35	Methyl Methacrylate	500	0.100	0.100

TABLE C-2 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	500	0.100	0.100
38	Methylene Chloride	25	0.005	0.005
230	2-Nitropronane	NA	NA	NA
39	Pyridine	2000	0.400	0.400
	Styrene	25	0.005	0.005
40	1,1,1,2-Tetrachloroethane	25	0.005	0.005
41	1,1,2,2-Tetrachloroethane	25	0.005	0.005
42	Tetrachloroethene	25	0.005	0.005
43	Toluene	25	0.005	0.005
44	Tribromomethane(bromoform)	25	0.005	0.005
45	1,1,1-Trichloroethane	25	0.005	0.005
46	1,1,2-Trichloroethane	25	0.005	0.005
47	Trichloroethene	25	0.005	0.005
48	Trichloromonofluoromethane	25	0.005	0.005
49	1,2,3-Trichloropropane	25	0.005	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	50	0.010	0.010
50	Vinyl Chloride	50	0.010	0.010
	Xylenes	25	0.005	0.005
	Semivolatile Organics			
51	Acenaphthalene	36000	0.420	0.010
52	Acenaphthene	36000	0.420	0.010
53	Acetophenone	72000	0.840	0.020
54	2-Acetylaminofluorene	72000	0.840	0.020
55	4-Aminobiphenyl	72000	0.840	0.020
56	Aniline	36000	0.420	0.010
57	Anthracene	36000	0.420	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	36000	0.420	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	180000	2.1	0.050
	Benzoic Acid	178000	2	0.010
62	Benzo(a)pyrene	36000	0.420	0.010
63	Benzo(b)fluoranthene	36000	0.420	0.010
64	Benzo(g,h,i) perylene	36000	0.420	0.010
65	Benzo(k)fluoranthene	36000	0.420	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	36000	0.420	0.010
67	Bis(2-Chloroethoxy) methane	36000	0.420	0.010
68	Bis(2-Chloroethyl) Ether	36000	0.420	0.010
69	Bis(2-chloroisopropyl) ether	36000	0.420	0.010
70	Bis(2-ethylhexyl) phthalate	36000	0.420	0.010
71	4-Bromophenyl phenyl ether	36000	0.420	0.010

TABLE C-2 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	36000	0.420	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	180000	2.1	0.050
74	p-Chloroaniline	36000	0.420	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	36000	0.420	0.010
77	2-Chloronaphthalene	36000	0.420	0.010
78	2-Chlorophenol	36000	0.420	0.010
	4-Chlorophenyl-phenyl ether	36000	0.420	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	36000	0.420	0.010
81	Ortho-cresol	36000	0.420	0.010
82	para-cresol	36000	0.420	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	36000	0.420	0.010
	Dibenzofuran	36000	0.420	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	36000	0.420	0.010
87	1,2-Dichlorobenzene	36000	0.420	0.010
88	1,4-Dichlorobenzene	36000	0.420	0.010
89	3,3'Dichlorobenzidine	72000	0.840	0.020
90	2,4-Dichlorophenol	36000	0.420	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	36000	0.420	0.010
93	3,3'-Dimethoxybenzidine	36000	0.420	0.010
94	p-Dimethylaminoazobenzene	72000	0.840	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	36000	0.420	0.010
97	Dimethyl Phthalate	36000	0.420	0.010
98	Di-n-butyl phthalate	36000	0.420	0.010
99	1,4-Dinitrobenzene	180000	2.1	0.050
100	4,6-dinitro-o-cresol	178000	2	0.050
101	2,4-Dinitrophenol	178000	2	0.050
102	2,4-Dinitrotoluene	36000	0.420	0.010
103	2,6-Dinitrotoluene	36000	0.420	0.010
104	Di-n-octyl phthalate	36000	0.420	0.010
105	Di-n-propylnitrosoamine	36000	0.420	0.010
106	Diphenylamine (1)	72000	0.840	0.020
107	1,2,-Diphenylhydrazine	180000	2.1	0.050
108	Fluoranthene	36000	0.420	0.010
109	Fluorene	36000	0.420	0.010
110	Hexachlorobenzene	36000	0.420	0.010
111	Hexachlorobutadiene	36000	0.420	0.010
112	Hexachlorocyclopentadiene	36000	0.420	0.010
113	Hexachloroethane	36000	0.420	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-2 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	36000	0.420	0.010
117	Isosafrole	72000	0.840	0.020
	Isophorone	36000	0.420	0.010
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	72000	0.840	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	72000	0.840	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methyl naphthalene	36000	0.420	0.010
121	Naphthalene	36000	0.420	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	180000	2.1	0.050
124	2-Naphthylamine	180000	2.1	0.050
	2-Nitroaniline	178000	2	0.050
	3-Nitroaniline	178000	2	0.050
125	p-Nitroaniline	178000	2	0.050
126	Nitrobenzene	36000	0.420	0.010
	2-Nitrophenol	36000	0.420	0.010
127	4-Nitrophenol	178000	2	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	36000	0.420	0.010
131	N-Nitrosomethylethylamine	36000	0.420	0.010
132	N-Nitrosomorpholine	36000	0.420	0.020
219	N-Nitrosodiphenylamine (1)	72000	0.840	0.010
133	1-Nitrosopiperidine	36000	0.420	0.010
134	N-Nitrosopyrrolidine	180000	2.1	0.050
135	2-Methyl-5-nitroaniline	72000	0.840	0.020
136	Pentachlorobenzene	ND	ND	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	360000	4.2	0.100
139	Pentachlorophenol	178000	2	0.050
140	Phenacetin	72000	0.840	0.020
141	Phenanthrene	36000	0.420	0.010
142	Phenol	36000	0.420	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	36000	0.420	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	36000	0.420	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	180000	2.1	0.050
148	1,2,4,5-Tetrachlorobenzene	72000	0.840	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	36000	0.420	0.010
151	2,4,5-Trichlorophenol	178000	2	0.050
152	2,4,6-Trichlorophenol	36000	0.420	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-2 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition			
154	Antimony	3.3	3.3	0.330
155	Arsenic	2.8	100	0.280
156	Barium	0.2	0.2	0.002
157	Beryllium	0.1	0.1	0.001
158	Cadmium	5.0	0.5	0.050
159	Chromium	0.4	0.4	0.004
221	Hexavalent Chromium	0.01	0.01	0.010
160	Copper	0.5	0.5	0.005
161	Lead	0.5	0.5	0.750
162	Mercury	0.02	0.02	0.0008
163	Nickel	1.1	1.1	0.011
164	Selenium	0.5	0.5	0.050
165	Silver	0.7	0.7	0.007
166	Thallium	5.0	1.0	0.100
167	Vanadium	0.4	0.4	0.004
168	Zinc	0.4	0.4	0.004
	Metals - TCLP (mg/l)			
154	Antimony	NOT ANALYZED	0.033	NOT ANALYZED
155	Arsenic		0.200	
156	Barium		0.002	
157	Beryllium		0.001	
158	Cadmium		0.005	
159	Chromium		0.004	
160	Copper		0.005	
161	Lead		0.005	
162	Mercury		0.0002	
163	Nickel		0.011	
164	Selenium		0.005	
165	Silver		0.007	
166	Thallium		0.010	
167	Vanadium		0.004	
168	Zinc		0.004	
	Inorganics			
169	Cyanide	0.010	0.010	0.010
170	Flouride	0.2	0.2	0.2
171	Sulfide	0.5	0.5	0.5
	Other Parameters			
	Chlorides	1	1	1
	Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-3 DETECTION LIMITS FOR K101 SAMPLE SET #2

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics			
222	Acetone	50	0.010	0.010
1	Acetonitrile	500	0.100	0.100
2	Acrolein	500	0.100	0.100
3	Acrylonitrile	500	0.100	0.100
4	Benzene	25	0.005	0.005
5	Bromodichloromethane	25	0.005	0.005
6	Bromomethane	50	0.010	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	25	0.005	0.005
8	Carbon Disulfide	25	0.005	0.005
9	Chlorobenzene	25	0.005	0.005
10	2-Chloro-1,3-Butadiene	500	0.100	0.100
11	Chlorodibromomethane	25	0.005	0.005
12	Chloroethane	50	0.010	0.010
13	2-Chloroethylvinylether	50	0.010	0.010
14	Chloroform	25	0.005	0.005
15	Chloromethane	50	0.010	0.010
16	3-Chloropropene	500	0.100	0.100
17	1,2-Dibromo-3-Chloropropane	50	0.010	0.010
18	1,2-Dibromoethane	25	0.005	0.005
19	Dibromomethane	25	0.005	0.005
20	Trans-1,4-Dichloro-2-Butene	500	0.100	0.100
21	Dichlorodifluoromethane	50	0.010	0.010
22	1,1-Dichloroethane	25	0.005	0.005
23	1,2-Dichloroethane	25	0.005	0.005
24	1,1-Dichloroethene	25	0.005	0.005
25	Trans-1,2-Dichloroethene	25	0.005	0.005
26	1,2-Dichloropropane	25	0.005	0.005
27	Trans-1,3-Dichloropropene	25	0.005	0.005
28	cis-1,3,Dichloropropene	25	0.005	0.005
29	1,4-Dioxane	1000	0.200	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	25	0.005	0.005
30	Ethyl Cyanide	500	0.100	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	500	0.100	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	250	0.050	0.050
33	Isobutyl Alcohol	1000	0.200	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	50	0.010	0.010
34	Methyl ethyl ketone	50	0.010	0.010
229	Methyl isobutyl ketone	50	0.010	0.010
35	Methyl Methacrylate	500	0.100	0.100

TABLE C-3 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	500	0.100	0.100
38	Methylene Chloride	25	0.005	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	2000	0.400	0.400
	Styrene	25	0.005	0.005
40	1,1,1,2-Tetrachloroethane	25	0.005	0.005
41	1,1,2,2-Tetrachloroethane	25	0.005	0.005
42	Tetrachloroethene	25	0.005	0.005
43	Toluene	25	0.005	0.005
44	Tribromomethane(bromoform)	25	0.005	0.005
45	1,1,1-Trichloroethane	25	0.005	0.005
46	1,1,2-Trichloroethane	25	0.005	0.005
47	Trichloroethene	25	0.005	0.005
48	Trichloromonofluoromethane	25	0.005	0.005
49	1,2,3-Trichloropropane	25	0.005	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	50	0.010	0.010
50	Vinyl Chloride	50	0.010	0.010
	Xylenes	25	0.005	0.005
	Semivolatile Organics			
51	Acenaphthalene	38000	0.420	0.010
52	Acenaphthene	38000	0.420	0.010
53	Acetophenone	76000	0.840	0.020
54	2-Acetylaminofluorene	76000	0.840	0.020
55	4-Aminobiphenyl	76000	0.840	0.020
56	Aniline	38000	0.420	0.010
57	Anthracene	38000	0.420	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	38000	0.420	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	190000	2.1	0.050
	Benzoic Acid	188000	2	0.010
62	Benzo(a)pyrene	38000	0.420	0.010
63	Benzo(b)fluoranthene	38000	0.420	0.010
64	Benzo(g,h,i) perylene	38000	0.420	0.010
65	Benzo(k)fluoranthene	38000	0.420	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	38000	0.420	0.010
67	Bis(2-Chloroethoxy) methane	38000	0.420	0.010
68	Bis(2-Chloroethyl) Ether	38000	0.420	0.010
69	Bis(2-chloroisopropyl) ether	38000	0.420	0.010
70	Bis(2-ethylhexyl) phthalate	38000	0.420	0.010
71	4-Bromophenyl phenyl ether	38000	0.420	0.010

TABLE C-3 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	38000	0.420	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	190000	2.1	0.050
74	p-Chloroaniline	38000	0.420	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	38000	0.420	0.010
77	2-Chloronaphthalene	38000	0.420	0.010
78	2-Chlorophenol	38000	0.420	0.010
	4-Chlorophenyl-phenyl ether	38000	0.420	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	38000	0.420	0.010
81	Ortho-cresol	38000	0.420	0.010
82	para-cresol	38000	0.420	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	38000	0.420	0.010
	Dibenzofuran	38000	0.420	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	38000	0.420	0.010
87	1,2-Dichlorobenzene	38000	0.420	0.010
88	1,4-Dichlorobenzene	38000	0.420	0.010
89	3,3'Dichlorobenzidine	76000	0.840	0.020
90	2,4-Dichlorophenol	38000	0.420	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	38000	0.420	0.010
93	3,3'-Dimethoxybenzidine	38000	0.420	0.010
94	p-Dimethylaminoazobenzene	76000	0.840	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	38000	0.420	0.010
97	Dimethyl Phthalate	38000	0.420	0.010
98	Di-n-butyl phthalate	38000	0.420	0.010
99	1,4-Dinitrobenzene	190000	2.1	0.050
100	4,6-dinitro-o-cresol	188000	2	0.050
101	2,4-Dinitrophenol	188000	2	0.050
102	2,4-Dinitrotoluene	38000	0.420	0.010
103	2,6-Dinitrotoluene	38000	0.420	0.010
104	Di-n-octyl phthalate	38000	0.420	0.010
105	Di-n-propylnitrosoamine	38000	0.420	0.010
106	Diphenylamine (1)	76000	0.840	0.020
107	1,2,-Diphenylhydrazine	190000	2.1	0.050
108	Fluoranthene	38000	0.420	0.010
109	Fluorene	38000	0.420	0.010
110	Hexachlorobenzene	38000	0.420	0.010
111	Hexachlorobutadiene	38000	0.420	0.010
112	Hexachlorocyclopentadiene	38000	0.420	0.010
113	Hexachloroethane	38000	0.420	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-3 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	38000	0.420	0.010
117	Isosafrole	76000	0.840	0.020
	Isophorone	38000	0.420	0.010
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	76000	0.840	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	76000	0.840	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methyl naphthalene	36000	0.420	0.010
121	Naphthalene	36000	0.420	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	180000	2.1	0.050
124	2-Naphthylamine	180000	2.1	0.050
	2-Nitroaniline	178000	2	0.050
	3-Nitroaniline	178000	2	0.050
125	p-Nitroaniline	178000	2	0.050
126	Nitrobenzene	38000	0.420	0.010
	2-Nitrophenol	38000	0.420	0.010
127	4-Nitrophenol	188000	2	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	38000	0.420	0.010
131	N-Nitrosomethylethylamine	38000	0.420	0.010
132	N-Nitrosomorpholine	38000	0.420	0.020
219	N-Nitrosodiphenylamine (1)	76000	0.840	0.010
133	1-Nitrosopiperidine	38000	0.420	0.010
134	N-Nitrosopyrrolidine	190000	2.1	0.050
135	2-Methyl-5-nitroaniline	76000	0.840	0.020
136	Pentachlorobenzene	ND	NQ	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	380000	4.2	0.100
139	Pentachlorophenol	188000	2	0.050
140	Phenacetin	76000	0.840	0.020
141	Phenanthrene	38000	0.420	0.010
142	Phenol	38000	0.420	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	38000	0.420	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	38000	0.420	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	190000	2.1	0.050
148	1,2,4,5-Tetrachlorobenzene	76000	0.840	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	38000	0.420	0.010
151	2,4,5-Trichlorophenol	188000	2	0.050
152	2,4,6-Trichlorophenol	38000	0.420	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-3 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition			
154	Antimony	3.3	3.3	0.330
155	Arsenic	2.8	100	0.280
156	Barium	0.2	0.2	0.002
157	Beryllium	0.1	0.1	0.001
158	Cadmium	5.0	0.5	0.500
159	Chromium	0.4	0.4	0.004
221	Hexavalent Chromium	0.01	0.01	0.010
160	Copper	0.5	0.5	0.005
161	Lead	2.0	0.5	0.750
162	Mercury	0.02	0.1	0.004
163	Nickel	1.1	1.1	0.011
164	Selenium	5.0	0.5	0.025
165	Silver	0.7	0.7	0.007
166	Thallium	5.0	1.0	0.020
167	Vanadium	0.4	0.4	0.004
168	Zinc	0.4	0.4	0.004
	Metals - TCLP (mg/l)			
154	Antimony	NOT ANALYZED	0.033	NOT ANALYZED
155	Arsenic		0.200	
156	Barium		0.002	
157	Beryllium		0.001	
158	Cadmium		0.005	
159	Chromium		0.004	
160	Copper		0.005	
161	Lead		0.005	
162	Mercury		0.0002	
163	Nickel		0.011	
164	Selenium		0.010	
165	Silver		0.007	
166	Thallium		0.010	
167	Vanadium		0.004	
168	Zinc		0.004	
	Inorganics			
169	Cyanide	0.010	0.010	0.010
170	Flouride	0.2	0.2	0.2
171	Sulfide	0.5	0.5	0.5
	Other Parameters			
	Chlorides	1	1	1
	Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-4 DETECTION LIMITS FOR K101 SAMPLE SET #3

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics			
222	Acetone	50	0.010	0.010
1	Acetonitrile	500	0.100	0.100
2	Acrolein	500	0.100	0.100
3	Acrylonitrile	500	0.100	0.100
4	Benzene	25	0.005	0.005
5	Bromodichloromethane	25	0.005	0.005
6	Bromomethane	50	0.010	0.010
223	n-butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	25	0.005	0.005
8	Carbon Disulfide	25	0.005	0.005
9	Chlorobenzene	25	0.005	0.005
10	2-Chloro-1,3-Butadiene	500	0.100	0.100
11	Chlorodibromomethane	25	0.005	0.005
12	Chloroethane	50	0.010	0.010
13	2-Chloroethylvinylether	50	0.010	0.010
14	Chloroform	25	0.005	0.005
15	Chloromethane	50	0.010	0.010
16	3-Chloropropene	500	0.100	0.100
17	1,2-Dibromo-3-Chloropropane	50	0.010	0.010
18	1,2-Dibromoethane	25	0.005	0.005
19	Dibromomethane	25	0.005	0.005
20	Trans-1,4-Dichloro-2-Butene	500	0.100	0.100
21	Dichlorodifluoromethane	50	0.010	0.010
22	1,1-Dichloroethane	25	0.005	0.005
23	1,2-Dichloroethane	25	0.005	0.005
24	1,1-Dichloroethene	25	0.005	0.005
25	Trans-1,2-Dichloroethene	25	0.005	0.005
26	1,2-Dichloropropane	25	0.005	0.005
27	Trans-1,3-Dichloropropene	25	0.005	0.005
28	cis-1,3,Dichloropropene	25	0.005	0.005
29	1,4-Dioxane	1000	0.200	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	25	0.005	0.005
30	Ethyl Cyanide	500	0.100	0.100
227	Ethyl Acetate	NA	NA	NA
31	Ethyl Methacrylate	500	0.100	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	250	0.050	0.050
33	Isobutyl Alcohol	1000	0.200	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	50	0.010	0.010
34	Methyl ethyl ketone	50	0.010	0.010
229	Methyl isobutyl ketone	50	0.010	0.010
35	Methyl Methacrylate	500	0.100	0.100

TABLE C-4 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	500	0.100	0.100
38	Methylene Chloride	25	0.005	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	2000	0.400	0.400
	Styrene	25	0.005	0.005
40	1,1,1,2-Tetrachloroethane	25	0.005	0.005
41	1,1,2,2-Tetrachloroethane	25	0.005	0.005
42	Tetrachloroethene	25	0.005	0.005
43	Toluene	25	0.005	0.005
44	Tribromomethane(bromoform)	25	0.005	0.005
45	1,1,1-Trichloroethane	25	0.005	0.005
46	1,1,2-Trichloroethane	25	0.005	0.005
47	Trichloroethene	25	0.005	0.005
48	Trichloromonofluoromethane	25	0.005	0.005
49	1,2,3-Trichloropropane	25	0.005	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	50	0.010	0.010
50	Vinyl Chloride	50	0.010	0.010
	Xylenes	25	0.005	0.005
	Semivolatile Organics			
51	Acenaphthalene	34000	0.420	0.010
52	Acenaphthene	34000	0.420	0.010
53	Acetophenone	68000	0.840	0.020
54	2-Acetylaminofluorene	68000	0.840	0.020
55	4-Aminobiphenyl	68000	0.840	0.020
56	Aniline	34000	0.420	0.010
57	Anthracene	34000	8.420	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	34000	0.420	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	170000	2.1	0.050
	Benzoic Acid	172000	2	0.010
62	Benzo(a)pyrene	34000	0.420	0.010
63	Benzo(b)fluoranthene	34000	0.420	0.010
64	Benzo(g,h,i) perylene	34000	0.420	0.010
65	Benzo(k)fluoranthene	34000	0.420	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	34000	0.420	0.010
67	Bis(2-Chloroethoxy) methane	34000	0.420	0.010
68	Bis(2-Chloroethyl) Ether	34000	0.420	0.010
69	Bis(2-chloroisopropyl) ether	34000	0.420	0.010
70	Bis(2-ethylhexyl) phthalate	34000	0.420	0.010
71	4-Bromophenyl phenyl ether	34000	0.420	0.010

TABLE C-4 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	34000	0.420	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	170000	2.1	0.050
74	p-Chloroaniline	34000	0.420	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	34000	0.420	0.010
77	2-Chloronaphthalene	34000	0.420	0.010
78	2-Chlorophenol	34000	0.420	0.010
	4-Chlorophenyl-phenyl ether	34000	0.420	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	34000	0.420	0.010
81	Ortho-cresol	34000	0.420	0.010
82	para-cresol	34000	0.420	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	34000	0.420	0.010
	Dibenzofuran	34000	0.420	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	34000	0.420	0.010
87	1,2-Dichlorobenzene	34000	0.420	0.010
88	1,4-Dichlorobenzene	34000	0.420	0.010
89	3,3'Dichlorobenzidine	68000	0.840	0.020
90	2,4-Dichlorophenol	34000	0.420	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	34000	0.420	0.010
93	3,3'-Dimethoxybenzidine	34000	0.420	0.010
94	p-Dimethylaminoazobenzene	68000	0.840	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	34000	0.420	0.010
97	Dimethyl Phthalate	34000	0.420	0.010
98	Di-n-butyl phthalate	34000	0.420	0.010
99	1,4-Dinitrobenzene	170000	2.1	0.050
100	4,6-dinitro-o-cresol	172000	2	0.050
101	2,4-Dinitrophenol	172000	2	0.050
102	2,4-Dinitrotoluene	34000	0.420	0.010
103	2,6-Dinitrotoluene	34000	0.420	0.010
104	Di-n-octyl phthalate	34000	0.420	0.010
105	Di-n-propylnitrosamine	34000	0.420	0.010
106	Diphenylamine (1)	68000	0.840	0.020
107	1,2,-Diphenylhydrazine	170000	2.1	0.050
108	Fluoranthene	34000	0.420	0.010
109	Fluorene	34000	0.420	0.010
110	Hexachlorobenzene	34000	0.420	0.010
111	Hexachlorobutadiene	34000	0.420	0.010
112	Hexachlorocyclopentadiene	34000	0.420	0.010
113	Hexachloroethane	34000	0.420	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-4 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	34000	0.420	0.010
117	Isosafrole	68000	0.840	0.020
	Isophorone	34000	0.420	0.010
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	68000	0.840	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	68000	0.840	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methyl naphthalene	34000	0.420	0.010
121	Naphthalene	34000	0.420	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	170000	2.1	0.050
124	2-Naphthylamine	170000	2.1	0.050
	2-Nitroaniline	172000	2	0.050
	3-Nitroaniline	172000	2	0.050
125	p-Nitroaniline	172000	2	0.050
126	Nitrobenzene	34000	0.420	0.010
	2-Nitrophenol	34000	0.420	0.010
127	4-Nitrophenol	172000	2	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	34000	0.420	0.010
131	N-Nitrosomethylethylamine	34000	0.420	0.010
132	N-Nitrosomorpholine	34000	0.420	0.020
219	N-Nitrosodiphenylamine (1)	68000	0.840	0.010
133	1-Nitrosopiperidine	34000	0.420	0.010
134	N-Nitrosopyrrolidine	170000	2.1	0.050
135	2-Methyl-5-nitroaniline	68000	0.840	0.020
136	Pentachlorobenzene	ND	ND	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	340000	4.2	0.100
139	Pentachlorophenol	172000	2	0.050
140	Phenacetin	68000	0.840	0.020
141	Phenanthrene	34000	0.420	0.010
142	Phenol	34000	0.420	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	34000	0.420	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	34000	0.420	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	170000	2.1	0.050
148	1,2,4,5-Tetrachlorobenzene	68000	0.840	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	34000	0.420	0.010
151	2,4,5-Trichlorophenol	172000	2	0.050
152	2,4,6-Trichlorophenol	34000	0.420	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-4 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition			
154	Antimony	3.3	3.3	0.330
155	Arsenic	2.8	100	0.280
156	Barium	0.2	0.2	0.002
157	Beryllium	0.1	0.1	0.001
158	Cadmium	5.0	0.5	0.500
159	Chromium	0.4	0.4	0.004
221	Hexavalent Chromium	0.01	0.01	0.010
160	Copper	0.5	0.5	0.005
161	Lead	0.5	0.5	0.500
162	Mercury	0.02	0.1	0.004
163	Nickel	1.1	1.1	0.011
164	Selenium	0.5	0.5	0.050
165	Silver	0.7	0.7	0.070
166	Thallium	5.0	1.0	0.010
167	Vanadium	0.4	0.4	0.004
168	Zinc	0.4	0.4	0.004
	Metals - TCLP (mg/l)			
154	Antimony	NOT ANALYZED	0.033	NOT ANALYZED
155	Arsenic		0.100	
156	Barium		0.002	
157	Beryllium		0.001	
158	Cadmium		0.005	
159	Chromium		0.004	
160	Copper		0.005	
161	Lead		0.005	
162	Mercury		0.0002	
163	Nickel		0.011	
164	Selenium		0.025	
165	Silver		0.070	
166	Thallium		0.010	
167	Vanadium		0.004	
168	Zinc		0.004	
	Inorganics			
169	Cyanide	0.010	0.010	0.010
170	Flouride	0.2	0.2	0.2
171	Sulfide	0.5	0.5	0.5
	Other Parameters			
	Chlorides	1	1	1
	Sulfates	5	5	5

(1) - Cannot be seperated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-5 DETECTION LIMITS FOR K101 SAMPLE SET #4

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics		
222	Acetone	50	0.010
1	Acetonitrile	500	0.100
2	Acrolein	500	0.100
3	Acrylonitrile	500	0.100
4	Benzene	25	0.005
5	Bromodichloromethane	25	0.005
6	Bromomethane	50	0.010
223	n-Butyl Alcohol	NA	NA
7	Carbon Tetrachloride	25	0.005
8	Carbon Disulfide	25	0.005
9	Chlorobenzene	25	0.005
10	2-Chloro-1,3-Butadiene	500	0.100
11	Chlorodibromomethane	25	0.005
12	Chloroethane	50	0.010
13	2-Chloroethylvinylether	50	0.010
14	Chloroform	25	0.005
15	Chloromethane	50	0.010
16	3-Chloropropene	500	0.100
17	1,2-Dibromo-3-Chloropropane	50	0.010
18	1,2-Dibromoethane	25	0.005
19	Dibromomethane	25	0.005
20	Trans-1,4-Dichloro-2-Butene	500	0.100
21	Dichlorodifluoromethane	50	0.010
22	1,1-Dichloroethane	25	0.005
23	1,2-Dichloroethane	25	0.005
24	1,1-Dichloroethene	25	0.005
25	Trans-1,2-Dichloroethene	25	0.005
26	1,2-Dichloropropane	25	0.005
27	Trans-1,3-Dichloropropene	25	0.005
28	cis-1,3,Dichloropropene	25	0.005
29	1,4-Dioxane	1000	0.200
224	2-Ethoxyethanol	NA	NA
225	Ethyl Acetate	NA	NA
226	Ethylbenzene	25	0.005
30	Ethyl Cyanide	500	0.100
227	Ethyl Ether	NA	NA
31	Ethyl Methacrylate	500	0.100
214	Ethylene Oxide	NA	NA
32	Iodomethane	250	0.050
33	Isobutyl Alcohol	1000	0.200
228	Methanol	NA	NA
	Methyl butyl ketone	50	0.010
34	Methyl ethyl ketone	50	0.010
229	Methyl isobutyl ketone	50	0.010
35	Methyl Methacrylate	500	0.100

TABLE C-5 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)		
37	Methacrylonitrile	500	0.100
38	Methylene Chloride	25	0.005
230	2-Nitropropane	NA	NA
39	Pyridine	2000	0.400
	Styrene	25	0.005
40	1,1,1,2-Tetrachloroethane	25	0.005
41	1,1,2,2-Tetrachloroethane	25	0.005
42	Tetrachloroethene	25	0.005
43	Toluene	25	0.005
44	Tribromomethane(bromoform)	25	0.005
45	1,1,1-Trichloroethane	25	0.005
46	1,1,2-Trichloroethane	25	0.005
47	Trichloroethene	25	0.005
48	Trichloromonofluoromethane	25	0.005
49	1,2,3-Trichloropropane	25	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA
	Vinyl Acetate	50	0.010
50	Vinyl Chloride	50	0.010
	Xylenes	25	0.005
	Semivolatile Organics		
51	Acenaphthalene	38000	0.010
52	Acenaphthene	38000	0.010
53	Acetophenone	76000	0.020
54	2-Acetylaminofluorene	76000	0.020
55	4-Aminobiphenyl	76000	0.020
56	Aniline	38000	0.010
57	Anthracene	38000	0.010
58	Aramite	NA	NA
59	Benzo(a)anthracene	38000	0.010
218	Benzal Chloride	NA	NA
60	Benzenethiol	ND	ND
61	Benzidine	190000	0.050
	Benzoic Acid	190000	0.010
62	Benzo(a)pyrene	38000	0.010
63	Benzo(b)fluoranthene	38000	0.010
64	Benzo(g,h,i) perylene	38000	0.010
65	Benzo(k)fluoranthene	38000	0.010
66	p-Benzoquinone	ND	ND
	Benzyl Alcohol	38000	0.010
67	Bis(2-Chloroethoxy) methane	38000	0.010
68	Bis(2-Chloroethyl) Ether	38000	0.010
69	Bis(2-chloroisopropyl) ether	38000	0.010
70	Bis(2-ethylhexyl) phthalate	38000	0.010
71	4-Bromophenyl phenyl ether	38000	0.010

TABLE C-5 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)		
72	Butyl benzyl phthalate	38000	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	190000	0.050
74	p-Chloroaniline	38000	0.010
75	Chlorobenzilate	NA	NA
76	p-Chloro-m-cresol	38000	0.010
77	2-Chloronaphthalene	38000	0.010
78	2-Chlorophenol	38000	0.010
	4-Chlorophenyl-phenyl ether	38000	0.010
79	3-Chloropropionitrile	NA	NA
80	Chrysene	38000	0.010
81	Ortho-cresol	38000	0.010
82	para-cresol	38000	0.010
232	Cyclohexanone	ND	ND
83	Dibenz(a,h)anthracene	38000	0.010
	Dibenzofuran	38000	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA
86	1,3-Dichlorobenzene	38000	0.010
87	1,2-Dichlorobenzene	38000	0.010
88	1,4-Dichlorobenzene	38000	0.010
89	3,3'Dichlorobenzidine	76000	0.020
90	2,4-Dichlorophenol	38000	0.010
91	2,6-Dichlorophenol	ND	ND
92	Diethyl phthalate	38000	0.010
93	3,3'-Dimethoxybenzidine	38000	0.010
94	p-Dimethylaminoazobenzene	76000	0.020
95	3,3'-Dimethylbenzidine	ND	ND
96	2,4-Dimethylphenol	38000	0.010
97	Dimethyl Phthalate	38000	0.010
98	Di-n-butyl phthalate	38000	0.010
99	1,4-Dinitrobenzene	190000	0.050
100	4,6-dinitro-o-cresol	190000	0.050
101	2,4-Dinitrophenol	190000	0.050
102	2,4-Dinitrotoluene	38000	0.010
103	2,6-Dinitrotoluene	38000	0.010
104	Di-n-octyl phthalate	38000	0.010
105	Di-n-propylnitrosoamine	38000	0.010
106	Diphenylamine (1)	76000	0.020
107	1,2,-Diphenylhydrazine	190000	0.050
108	Fluoranthene	38000	0.010
109	Fluorene	38000	0.010
110	Hexachlorobenzene	38000	0.010
111	Hexachlorobutadiene	38000	0.010
112	Hexachlorocyclopentadiene	38000	0.010
113	Hexachloroethane	38000	0.010
114	Hexachlorophene	NA	NA

TABLE C-5 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)		
115	Hexachloropropene	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	38000	0.010
117	Isosafrole	76000	0.020
	Isophorone	38000	0.010
118	Methapyrilene	NA	NA
119	3-Methylcholanthrene	76000	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	76000	0.020
36	Methyl Methanesulfonate	ND	ND
	2-Methyl naphthalene	36000	0.010
121	Naphthalene	36000	0.010
122	1,4-Naphthoquinone	NA	NA
123	1-Naphthylamine	180000	0.050
124	2-Naphthylamine	180000	0.050
	2-Nitroaniline	178000	0.050
	3-Nitroaniline	178000	0.050
125	p-Nitroaniline	178000	0.050
126	Nitrobenzene	38000	0.010
	2-Nitrophenol	38000	0.010
127	4-Nitrophenol	190000	0.050
128	N-Nitrosodi-n-butylamine	ND	ND
129	N-Nitrosodiethylamine	ND	ND
130	N-Nitrosodimethylamine	38000	0.010
131	N-Nitrosomethylethylamine	38000	0.010
132	N-Nitrosomorpholine	38000	0.020
219	N-Nitrosodiphenylamine (1)	76000	0.010
133	1-Nitrosopiperidine	38000	0.010
134	N-Nitrosopyrrolidine	190000	0.050
135	2-Methyl-5-nitroaniline	76000	0.020
136	Pentachlorobenzene	ND	ND
137	Pentachloroethane	NA	NA
138	Pentachloronitrobenzene	380000	0.100
139	Pentachlorophenol	190000	0.050
140	Phenacetin	76000	0.020
141	Phenanthrene	38000	0.010
142	Phenol	38000	0.010
220	Phthalic Anhydride	ND	ND
143	2-Picoline	38000	0.010
144	Pronamide	ND	ND
145	Pyrene	38000	0.010
146	Resorcinol	NA	NA
147	Safrole	190000	0.050
148	1,2,4,5-Tetrachlorobenzene	76000	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND
150	1,2,4-Trichlorobenzene	38000	0.010
151	2,4,5-Trichlorophenol	190000	0.050
152	2,4,6-Trichlorophenol	38000	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND

TABLE C-5 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition		
154	Antimony	3.3	0.330
155	Arsenic	2.8	0.280
156	Barium	0.2	0.002
157	Beryllium	0.1	0.001
158	Cadmium	5.0	0.500
159	Chromium	0.4	0.004
221	Hexavalent Chromium	0.01	0.010
160	Copper	0.5	0.005
161	Lead	1.0	0.500
162	Mercury	0.02	0.0002
163	Nickel	1.1	0.011
164	Selenium	5.0	0.500
165	Silver	0.7	0.070
166	Thallium	5.0	0.010
167	Vanadium	0.4	0.004
168	Zinc	0.4	0.004
	Metals - TCLP (mg/l)		
154	Antimony	NOT ANALYZED	NOT ANALYZED
155	Arsenic		
156	Barium		
157	Beryllium		
158	Cadmium		
159	Chromium		
160	Copper		
161	Lead		
162	Mercury		
163	Nickel		
164	Selenium		
165	Silver		
166	Thallium		
167	Vanadium		
168	Zinc		
	Inorganics		
169	Cyanide	-	0.010
170	Flouride	-	0.2
171	Sulfide	-	0.5
	Other Parameters		
	Chlorides	-	1
	Sulfates	-	5

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(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-6 DETECTION LIMITS FOR K102 BACKGROUND WATER, BACKGROUND QUENCH WATER, AND FINAL QUENCH WATER

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Volatile Organics			
222	Acetone	0.010	0.010	0.010
1	Acetonitrile	0.100	0.100	0.100
2	Acrolein	0.100	0.100	0.100
3	Acrylonitrile	0.100	0.100	0.100
4	Benzene	0.005	0.005	0.005
5	Bromodichloromethane	0.005	0.005	0.005
6	Bromomethane	0.010	0.010	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	0.005	0.005	0.005
8	Carbon Disulfide	0.005	0.005	0.005
9	Chlorobenzene	0.005	0.005	0.005
10	2-Chloro-1,3-Butadiene	0.100	0.100	0.100
11	Chlorodibromomethane	0.005	0.005	0.005
12	Chloroethane	0.010	0.010	0.010
13	2-Chloroethylvinylether	0.010	0.010	0.010
14	Chloroform	0.005	0.005	0.005
15	Chloromethane	0.010	0.010	0.010
16	3-Chloropropene	0.100	0.100	0.100
17	1,2-Dibromo-3-Chloropropane	0.010	0.010	0.010
18	1,2-Dibromoethane	0.005	0.005	0.005
19	Dibromomethane	0.005	0.005	0.005
20	Trans-1,4-Dichloro-2-Butene	0.100	0.100	0.100
21	Dichlorodifluoromethane	0.010	0.010	0.010
22	1,1-Dichloroethane	0.005	0.005	0.005
23	1,2-Dichloroethane	0.005	0.005	0.005
24	1,1-Dichloroethene	0.005	0.005	0.005
25	Trans-1,2-Dichloroethene	0.005	0.005	0.005
26	1,2-Dichloropropane	0.005	0.005	0.005
27	Trans-1,3-Dichloropropene	0.005	0.005	0.005
28	cis-1,3,Dichloropropene	0.005	0.005	0.005
29	1,4-Dioxane	0.200	0.200	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	0.005	0.005	0.005
30	Ethyl Cyanide	0.100	0.100	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	0.100	0.100	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	0.050	0.050	0.050
33	Isobutyl Alcohol	0.200	0.200	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	0.010	0.010	0.010
34	Methyl ethyl ketone	0.010	0.010	0.010
229	Methyl isobutyl ketone	0.010	0.010	0.010
35	Methyl Methacrylate	0.100	0.100	0.100

TABLE C-6 (Continued)

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	0.100	0.100	0.100
38	Methylene Chloride	0.005	0.005	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	0.400	0.400	0.400
	Styrene	0.005	0.005	0.005
40	1,1,1,2-Tetrachloroethane	0.005	0.005	0.005
41	1,1,2,2-Tetrachloroethane	0.005	0.005	0.005
42	Tetrachloroethene	0.005	0.005	0.005
43	Toluene	0.005	0.005	0.005
44	Tribromomethane(bromoform)	0.005	0.005	0.005
45	1,1,1-Trichloroethane	0.005	0.005	0.005
46	1,1,2-Trichloroethane	0.005	0.005	0.005
47	Trichloroethene	0.005	0.005	0.005
48	Trichloromonofluoromethane	0.005	0.005	0.005
49	1,2,3-Trichloropropane	0.005	0.005	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	0.010	0.010	0.010
50	Vinyl Chloride	0.010	0.010	0.010
	Xylenes	0.005	0.005	0.005
	Semivolatile Organics			
51	Acenaphthalene	0.010	0.010	0.010
52	Acenaphthene	0.010	0.010	0.010
53	Acetophenone	0.020	0.020	0.020
54	2-Acetylaminofluorene	0.020	0.020	0.020
55	4-Aminobiphenyl	0.020	0.020	0.020
56	Aniline	0.010	0.010	0.010
57	Anthracene	0.010	0.010	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	0.010	0.010	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	0.050	0.050	0.050
	Benzoic Acid	0.010	0.010	0.010
62	Benzo(a)pyrene	0.010	0.010	0.010
63	Benzo(b)fluoranthene	0.010	0.010	0.010
64	Benzo(g,h,i) perylene	0.010	0.010	0.010
65	Benzo(k)fluoranthene	0.010	0.010	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	0.010	0.010	0.010
67	Bis(2-Chloroethoxy) methane	0.010	0.010	0.010
68	Bis(2-Chloroethyl) Ether	0.010	0.010	0.010
69	Bis(2-chloroisopropyl) ether	0.010	0.010	0.010
70	Bis(2-ethylhexyl) phthalate	0.010	0.010	0.010
71	4-Bromophenyl phenyl ether	0.010	0.010	0.010

TABLE C-6 (Continued)

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	0.010	0.010	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	0.050	0.050	0.050
74	p-Chloroaniline	0.010	0.010	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	0.010	0.010	0.010
77	2-Chloronaphthalene	0.010	0.010	0.010
78	2-Chlorophenol	0.010	0.010	0.010
	4-Chlorophenyl-phenyl ether	0.010	0.010	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	0.010	0.010	0.010
81	Ortho-cresol	0.010	0.010	0.010
82	para-cresol	0.010	0.010	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	0.010	0.010	0.010
	Dibenzofuran	0.010	0.010	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	0.010	0.010	0.010
87	1,2-Dichlorobenzene	0.010	0.010	0.010
88	1,4-Dichlorobenzene	0.010	0.010	0.010
89	3,3'Dichlorobenzidine	0.020	0.020	0.020
90	2,4-Dichlorophenol	0.010	0.010	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	0.010	0.010	0.010
93	3,3'-Dimethoxybenzidine	0.010	0.010	0.010
94	p-Dimethylaminoazobenzene	0.020	0.020	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	0.010	0.010	0.010
97	Dimethyl Phthalate	0.010	0.010	0.010
98	Di-n-butyl phthalate	0.010	0.010	0.010
99	1,4-Dinitrobenzene	0.050	0.050	0.050
100	4,6-dinitro-o-cresol	0.050	0.050	0.050
101	2,4-Dinitrophenol	0.050	0.050	0.050
102	2,4-Dinitrotoluene	0.010	0.010	0.010
103	2,6-Dinitrotoluene	0.010	0.010	0.010
104	Di-n-octyl phthalate	0.010	0.010	0.010
105	Di-n-propylnitrosoamine	0.010	0.010	0.010
106	Diphenylamine (1)	0.020	0.020	0.020
107	1,2,-Diphenylhydrazine	0.050	0.050	0.050
108	Fluoranthene	0.010	0.010	0.010
109	Fluorene	0.010	0.010	0.010
110	Hexachlorobenzene	0.010	0.010	0.010
111	Hexachlorobutadiene	0.010	0.010	0.010
112	Hexachlorocyclopentadiene	0.010	0.010	0.010
113	Hexachloroethane	0.010	0.010	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-6 (Continued)

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	0.010	0.010	0.010
117	Isosafrole	0.020	0.020	0.020
	Isophorone	0.010	0.010	0.010
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	0.020	0.020	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	0.020	0.020	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methyl naphthalene	0.010	0.010	0.010
121	Naphthalene	0.010	0.010	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	0.050	0.050	0.050
124	2-Naphthylamine	0.050	0.050	0.050
	2-Nitroaniline	0.050	0.050	0.050
	3-Nitroaniline	0.050	0.050	0.050
125	p-Nitroaniline	0.050	0.050	0.050
126	Nitrobenzene	0.010	0.010	0.010
	2-Nitrophenol	0.010	0.010	0.010
127	4-Nitrophenol	0.050	0.050	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	0.010	0.010	0.010
131	N-Nitrosomethylethylamine	0.010	0.010	0.010
132	N-Nitrosomorpholine	0.020	0.020	0.020
219	N-Nitrosodiphenylamine (1)	0.010	0.010	0.010
133	1-Nitrosopiperidine	0.010	0.010	0.010
134	N-Nitrosopyrrolidine	0.050	0.050	0.050
135	2-Methyl-5-nitroaniline	0.020	0.020	0.020
136	Pentachlorobenzene	ND	ND	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	0.100	0.100	0.100
139	Pentachlorophenol	0.050	0.050	0.050
140	Phenacetin	0.020	0.020	0.020
141	Phenanthrene	0.010	0.010	0.010
142	Phenol	0.010	0.010	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	0.010	0.010	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	0.010	0.010	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	0.050	0.050	0.050
148	1,2,4,5-Tetrachlorobenzene	0.020	0.020	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	0.010	0.010	0.010
151	2,4,5-Trichlorophenol	0.050	0.050	0.050
152	2,4,6-Trichlorophenol	0.010	0.010	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-6 (Continued)

	BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
	Metals - Total Composition			
154	Antimony	0.015	0.033	0.015
155	Arsenic	0.028	0.028	0.010
156	Barium	0.002	0.002	0.002
157	Beryllium	0.001	0.001	0.001
158	Cadmium	0.005	0.005	0.005
159	Chromium	0.005	0.005	0.005
221	Hexavalent Chromium	0.010	0.010	0.010
160	Copper	0.004	0.004	0.004
161	Lead	0.005	0.005	0.005
162	Mercury	0.004	0.0002	0.0002
163	Nickel	0.009	0.009	0.009
164	Selenium	0.005	0.005	0.005
165	Silver	0.007	0.007	0.007
166	Thallium	0.050	0.010	0.050
167	Vanadium	0.003	0.003	0.003
168	Zinc	0.002	0.002	0.002
	Metals - TCLP			
154	Antimony			
155	Arsenic			
156	Barium			
157	Beryllium		NOT	
158	Cadmium			
159	Chromium			
160	Copper			ANALYZED
161	Lead			
162	Mercury			
163	Nickel			
164	Selenium			
165	Silver			
166	Thallium			
167	Vanadium			
168	Zinc			
	Inorganics			
169	Cyanide	0.010	0.010	0.010
170	Flouride	0.2	0.2	0.2
171	Sulfide	0.5	0.9	0.5
	Other Parameters			
	Chlorides	1	1	1
	Sulfates	5	5	5

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(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-7 DETECTION LIMITS FOR FOR K102 SAMPLE SET #1

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
222	Acetone	3	3	0.010
1	Acetonitrile	30	30	0.100
2	Acrolein	30	30	0.100
3	Acrylonitrile	30	30	0.100
4	Benzene	1.5	1.5	0.005
5	Bromodichloromethane	1.5	1.5	0.005
6	Bromomethane	3	3	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	1.5	1.5	0.005
8	Carbon Disulfide	1.5	1.5	0.005
9	Chlorobenzene	1.5	1.5	0.005
10	2-Chloro-1,3-Butadiene	30	30	0.100
11	Chlorodibromomethane	1.5	1.5	0.005
12	Chloroethane	3	3	0.010
13	2-Chloroethylvinylether	3	3	0.010
14	Chloroform	1.5	1.5	0.005
15	Chloromethane	3	3	0.010
16	3-Chloropropene	30	30	0.100
17	1,2-Dibromo-3-Chloropropane	3	3	0.010
18	1,2-Dibromoethane	1.5	1.5	0.005
19	Dibromomethane	1.5	1.5	0.005
20	Trans-1,4-Dichloro-2-Butene	30	30	0.100
21	Dichlorodifluoromethane	3	3	0.010
22	1,1-Dichloroethane	1.5	1.5	0.005
23	1,2-Dichloroethane	1.5	1.5	0.005
24	1,1-Dichloroethene	1.5	1.5	0.005
25	Trans-1,2-Dichloroethene	1.5	1.5	0.005
26	1,2-Dichloropropane	1.5	1.5	0.005
27	Trans-1,3-Dichloropropene	1.5	1.5	0.005
28	cis-1,3,Dichloropropene	1.5	1.5	0.005
29	1,4-Dioxane	60	60	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	1.5	1.5	0.005
30	Ethyl Cyanide	30	30	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	30	30	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	15	15	0.050
33	Isobutyl Alcohol	60	60	0.200
228	Methanol	NA	NA	NA
	Mehtyl butyl ketone	3	3	0.010
34	Methyl ethyl ketone	3	3	0.010
229	Methyl isobutyl ketone	3	3	0.010
35	Methyl Methacrylate	30	30	0.100

TABLE C-7 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	30	30	0.100
38	Methylene Chloride	1.5	1.5	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	120	120	0.400
	Styrene	1.5	1.5	0.005
40	1,1,1,2-Tetrachloroethane	1.5	1.5	0.005
41	1,1,2,2-Tetrachloroethane	1.5	1.5	0.005
42	Tetrachloroethene	1.5	1.5	0.005
43	Toluene	1.5	1.5	0.005
44	Tribromomethane(bromoform)	1.5	1.5	0.005
45	1,1,1-Trichloroethane	1.5	1.5	0.005
46	1,1,2-Trichloroethane	1.5	1.5	0.005
47	Trichloroethene	1.5	1.5	0.005
48	Trichloromonofluoromethane	1.5	1.5	0.005
49	1,2,3-Trichloropropane	1.5	1.5	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	3	3	0.010
50	Vinyl Chloride	3	3	0.010
	Xylenes	1.5	1.5	0.005
	Semivolatile Organics			
51	Acenaphthalene	182	1	0.010
52	Acenaphthene	182	1	0.010
53	Acetophenone	364	2	0.020
54	2-Acetylaminofluorene	364	2	0.020
55	4-Aminobiphenyl	364	2	0.020
56	Aniline	182	1	0.010
57	Anthracene	182	1	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	182	1	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	910	5	0.050
	Benzoic Acid	910	5	0.010
62	Benzo(a)pyrene	182	1	0.010
63	Benzo(b)fluoranthene	182	1	0.010
64	Benzo(g,h,i) perylene	182	1	0.010
65	Benzo(k)fluoranthene	182	1	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	182	1	0.010
67	Bis(2-Chloroethoxy) methane	182	1	0.010
68	Bis(2-Chloroethyl) Ether	182	1	0.010
69	Bis(2-chloroisopropyl) ether	182	1	0.010
70	Bis(2-ethylhexyl) phthalate	182	1	0.010
71	4-Bromophenyl phenyl ether	182	1	0.010

TABLE C-7 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	182	1	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	910	5	0.050
74	p-Chloroaniline	182	1	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	182	1	0.010
77	2-Chloronaphthalene	182	1	0.010
78	2-Chlorophenol	182	1	0.010
	4-Chlorophenyl-phenyl ether	182	1	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	182	1	0.010
81	Ortho-cresol	182	1	0.010
82	para-cresol	182	1	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	182	1	0.010
	Dibenzofuran	182	1	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	182	1	0.010
87	1,2-Dichlorobenzene	182	1	0.010
88	1,4-Dichlorobenzene	182	1	0.010
89	3,3'Dichlorobenzidine	364	2	0.020
90	2,4-Dichlorophenol	182	1	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	182	1	0.010
93	3,3'-Dimethoxybenzidine	182	1	0.010
94	p-Dimethylaminoazobenzene	364	2	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	182	1	0.010
97	Dimethyl Phthalate	182	1	0.010
98	Di-n-butyl phthalate	182	1	0.010
99	1,4-Dinitrobenzene	910	5	0.050
100	4,6-dinitro-o-cresol	910	5	0.050
101	2,4-Dinitrophenol	910	5	0.050
102	2,4-Dinitrotoluene	182	1	0.010
103	2,6-Dinitrotoluene	182	1	0.010
104	Di-n-octyl phthalate	182	1	0.010
105	Di-n-propylnitrosoamine	182	1	0.010
106	Diphenylamine (1)	364	2	0.020
107	1,2,-Diphenylhydrazine	910	5	0.050
108	Fluoranthene	182	1	0.010
109	Fluorene	182	1	0.010
110	Hexachlorobenzene	182	1	0.010
111	Hexachlorobutadiene	182	1	0.010
112	Hexachlorocyclopentadiene	182	1	0.010
113	Hexachloroethane	182	1	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-7 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	182	1	0.010
117	Isosafrole	364	2	0.020
	Isophorone	182	1	0.010
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	364	2	0.020
120	4,4′-Methylene-bis-(2-chloroaniline)	364	2	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methylnaphthalene	182	1	0.010
121	Naphthalene	182	1	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	910	5	0.050
124	2-Naphthylamine	910	5	0.050
	2-Nitroaniline	910	5	0.050
	3-Nitroaniline	910	5	0.050
125	p-Nitroaniline	910	5	0.050
126	Nitrobenzene	182	1	0.010
	2-Nitrophenol	182	1	0.010
127	4-Nitrophenol	910	5	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	182	1	0.010
219	N-Nitrosodiphenylamine (1)	182	1	0.010
131	N-Nitrosomethylethylamine	182	1	0.020
132	N-Nitrosomorpholine	364	2	0.010
133	1-Nitrosopiperidine	182	1	0.010
134	N-Nitrosopyrrolidine	910	5	0.050
135	2-Methyl-5-nitroaniline	364	2	0.020
136	Pentachlorobenzene	ND	ND	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	1820	1	0.100
139	Pentachlorophenol	910	5	0.050
140	Phenacetin	364	2	0.020
141	Phenanthrene	182	1	0.010
142	Phenol	182	1	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	182	1	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	182	1	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	910	5	0.050
148	1,2,4,5-Tetrachlorobenzene	364	2	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	182	1	0.010
151	2,4,5-Trichlorophenol	910	5	0.050
152	2,4,6-Trichlorophenol	182	1	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-7 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition			
154	Antimony	1.5	1.5	0.015
155	Arsenic	1.0	1.0	0.010
156	Barium	0.2	0.2	0.002
157	Beryllium	0.1	0.1	0.010
158	Cadmium	0.5	0.5	0.005
159	Chromium	0.5	0.5	0.005
	Hexavalent Chromium (mg/l)	0.01	0.01	0.010
160	Copper	0.4	0.4	0.004
161	Lead	0.5	0.5	0.005
162	Mercury	0.1	0.1	0.0002
163	Nickel	0.9	0.9	0.220
164	Selenium	0.5	0.5	0.005
165	Silver	0.7	0.7	0.005
166	Thallium	1.0	5.0	0.010
167	Vanadium	0.4	0.3	0.003
168	Zinc	0.2	0.2	0.002
	Metals - TCLP (mg/l)			
154	Antimony		0.015	
155	Arsenic		0.010	
156	Barium		0.002	
157	Beryllium	NOT	0.001	NOT
158	Cadmium		0.005	
159	Chromium		0.005	
160	Copper	ANALYZED	0.004	ANALYZED
161	Lead		0.005	
162	Mercury		0.0002	
163	Nickel		0.009	
164	Selenium		0.050	
165	Silver		0.007	
166	Thallium		0.500	
167	Vanadium		0.004	
168	Zinc		0.002	
	Inorganics			
169	Cyanide	-	-	0.010
170	Flouride	-	-	0.2
171	Sulfide	-	-	0.5
	Other Parameters			
	Chlorides	-	-	1
	Sulfates	-	-	5

(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

- - No detection limit established.

TABLE C-8 DETECTION LIMITS FOR K102 SAMPLE SETS #2 AND #3

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics			
222	Acetone	3	3	0.010
1	Acetonitrile	30	30	0.100
2	Acrolein	30	30	0.100
3	Acrylonitrile	30	30	0.100
4	Benzene	1.5	1.5	0.005
5	Bromodichloromethane	1.5	1.5	0.005
6	Bromomethane	3	3	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	1.5	1.5	0.005
8	Carbon Disulfide	1.5	1.5	0.005
9	Chlorobenzene	1.5	1.5	0.005
10	2-Chloro-1,3-Butadiene	30	30	0.100
11	Chlorodibromomethane	1.5	1.5	0.005
12	Chloroethane	3	3	0.010
13	2-Chloroethylvinylether	3	3	0.010
14	Chloroform	1.5	1.5	0.005
15	Chloromethane	3	3	0.010
16	3-Chloropropene	30	30	0.100
17	1,2-Dibromo-3-Chloropropane	3	3	0.010
18	1,2-Dibromoethane	1.5	1.5	0.005
19	Dibromomethane	1.5	1.5	0.005
20	Trans-1,4-Dichloro-2-Butene	30	30	0.100
21	Dichlorodifluoromethane	3	3	0.010
22	1,1-Dichloroethane	1.5	1.5	0.005
23	1,2-Dichloroethane	1.5	1.5	0.005
24	1,1-Dichloroethene	1.5	1.5	0.005
25	Trans-1,2-Dichloroethene	1.5	1.5	0.005
26	1,2-Dichloropropane	1.5	1.5	0.005
27	Trans-1,3-Dichloropropene	1.5	1.5	0.005
28	cis-1,3,Dichloropropene	1.5	1.5	0.005
29	1,4-Dioxane	60	60	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	1.5	1.5	0.005
30	Ethyl Cyanide	30	30	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	30	30	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	15	15	0.050
33	Isobutyl Alcohol	60	60	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	3	3	0.010
34	Methyl ethyl ketone	3	3	0.010
229	Methyl isobutyl ketone	3	3	0.010
35	Methyl Methacrylate	30	30	0.100

TABLE C-8 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	30	30	0.100
38	Methylene Chloride	1.5	1.5	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	120	120	0.400
	Styrene	1.5	1.5	0.005
40	1,1,1,2-Tetrachloroethane	1.5	1.5	0.005
41	1,1,2,2-Tetrachloroethane	1.5	1.5	0.005
42	Tetrachloroethene	1.5	1.5	0.005
43	Toluene	1.5	1.5	0.005
44	Tribromomethane(bromoform)	1.5	1.5	0.005
45	1,1,1-Trichloroethane	1.5	1.5	0.005
46	1,1,2-Trichloroethane	1.5	1.5	0.005
47	Trichloroethene	1.5	1.5	0.005
48	Trichloromonofluoromethane	1.5	1.5	0.005
49	1,2,3-Trichloropropane	1.5	1.5	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	3	3	0.010
50	Vinyl Chloride	3	3	0.010
	Xylenes	1.5	1.5	0.005
	Semivolatile Organics			
51	Acenaphthalene	19.4	1	0.010
52	Acenaphthene	19.4	1	0.010
53	Acetophenone	38.8	2	0.020
54	2-Acetylaminofluorene	38.8	2	0.020
55	4-Aminobiphenyl	38.8	2	0.020
56	Aniline	19.4	1	0.010
57	Anthracene	19.4	1	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	19.4	1	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	97	5	0.050
	Benzoic Acid	98	5	0.010
62	Benzo(a)pyrene	19.4	1	0.010
63	Benzo(b)fluoranthene	19.4	1	0.010
64	Benzo(g,h,i) perylene	19.4	1	0.010
65	Benzo(k)fluoranthene	19.4	1	0.010
66	p-Benzoquinone*SP	ND	ND	ND
	Benzyl Alcohol	19.4	1	0.010
67	Bis(2-Chloroethoxy) methane	19.4	1	0.010
68	Bis(2-Chloroethyl) Ether	19.4	1	0.010
69	Bis(2-chloroisopropyl) ether	19.4	1	0.010
70	Bis(2-ethylhexyl) phthalate	19.4	1	0.010
71	4-Bromophenyl phenyl ether	19.4	1	0.010

TABLE C-8 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	19.4	1	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	97	5	0.050
74	p-Chloroaniline	19.4	1	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	19.4	1	0.010
77	2-Chloronaphthalene	19.4	1	0.010
78	2-Chlorophenol	19.4	1	0.010
	4-Chlorophenyl-phenyl ether	19.4	1	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	19.4	1	0.010
81	Ortho-cresol	19.4	1	0.010
82	para-cresol	19.4	1	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	19.4	1	0.010
	Dibenzofuran	19.4	1	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	19.4	1	0.010
87	1,2-Dichlorobenzene	19.4	1	0.010
88	1,4-Dichlorobenzene	19.4	1	0.010
89	3,3'Dichlorobenzidine	38	2	0.020
90	2,4-Dichlorophenol	19.4	1	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	19.4	1	0.010
93	3,3'-Dimethoxybenzidine	19.4	1	0.010
94	p-Dimethylaminoazobenzene	38.8	2	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	19.4	1	0.010
97	Dimethyl Phthalate	19.4	1	0.010
98	Di-n-butyl phthalate	19.4	1	0.010
99	1,4-Dinitrobenzene	97	5	0.050
100	4,6-dinitro-o-cresol	98	5	0.050
101	2,4-Dinitrophenol	98	5	0.050
102	2,4-Dinitrotoluene	19.4	1	0.010
103	2,6-Dinitrotoluene	19.4	1	0.010
104	Di-n-octyl phthalate	19.4	1	0.010
105	Di-n-propylnitrosoamine	19.4	1	0.010
106	Diphenylamine (1)	38.8	2	0.020
107	1,2,-Diphenylhydrazine	97	5	0.050
108	Fluoranthene	19.4	1	0.010
109	Fluorene	19.4	1	0.010
110	Hexachlorobenzene	19.4	1	0.010
111	Hexachlorobutadiene	19.4	1	0.010
112	Hexachlorocyclopentadiene	19.4	1	0.010
113	Hexachloroethane	19.4	1	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-8 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	19.4	1	0.010
117	Isosafrole	38.8	2	0.010
	Isophorone	19.4	1	0.020
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	38.8	2	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	38.8	2	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methylnaphthalene	19.4	1	0.010
121	Naphthalene	19.4	1	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	97	5	0.050
124	2-Naphthylamine	97	5	0.050
	2-Nitroaniline	98	5	0.050
	3-Nitroaniline	98	5	0.050
125	p-Nitroaniline	98	5	0.050
126	Nitrobenzene	19.4	1	0.010
	2-Nitrophenol	19.4	1	0.010
127	4-Nitrophenol	98	5	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	19.4	1	0.010
219	N-Nitrosodiphenylamine (1)	19.4	1	0.010
131	N-Nitrosomethylethylamine	19.4	1	0.020
132	N-Nitrosomorpholine	38.8	2	0.010
133	1-Nitrosopiperidine	19.4	1	0.010
134	N-Nitrosopyrrolidine	97	5	0.050
135	2-Methyl-5-nitroaniline	38.8	2	0.020
136	Pentachlorobenzene	ND	ND	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	194	1	0.100
139	Pentachlorophenol	98	5	0.050
140	Phenacetin	38.8	2	0.020
141	Phenanthrene	19.4	1	0.010
142	Phenol	19.4	1	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	19.4	1	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	19.4	1	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	97	5	0.050
148	1,2,4,5-Tetrachlorobenzene	38.8	2	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	19.4	1	0.010
151	2,4,5-Trichlorophenol	98	5	0.050
152	2,4,6-Trichlorophenol	19.4	1	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-8 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition			
154	Antimony	1.5	1.5	0.015
155	Arsenic	1.0	1.0	0.010
156	Barium	0.2	0.2	0.002
157	Beryllium	0.1	0.1	0.001
158	Cadmium	0.5	0.5	0.005
159	Chromium	0.5	0.5	0.005
221	Hexavalent Chromium (mg/l)	0.01	0.01	0.010
160	Copper	0.4	0.4	0.004
161	Lead	0.5	0.5	0.005
162	Mercury	0.1	0.1	0.0002
163	Nickel	0.9	0.9	0.220**
164	Selenium	0.5	0.5	0.005
165	Silver	0.7	0.7	0.005
166	Thallium	1.0	1.0	0.010
167	Vanadium	0.4	0.4	0.003
168	Zinc	0.2	0.2	0.002
	Metals - TCLP (mg/l)			
154	Antimony	NOT ANALYZED	0.015	NOT ANALYZED
155	Arsenic		0.010	
156	Barium		0.002	
157	Beryllium		0.001	
158	Cadmium		0.005	
159	Chromium		0.007+	
160	Copper		0.004	
161	Lead		0.005	
162	Mercury		0.0002+	
163	Nickel		0.009	
164	Selenium		0.005	
165	Silver		0.007+	
166	Thallium		0.200+	
167	Vanadium		0.004+	
168	Zinc		0.002	

TABLE C-8 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Inorganics			
169	Cyanide	-	-	0.01
170	Flouride	-	-	0.2
171	Sulfide	-	-	0.5
	Other Parameters			
	Chlorides	-	-	1
	Sulfates	-	-	5

(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

** - Detection limit for sample set 3 for Nickel is 0.110 mg/l.

+ - Detection limits for sample set 3 for Chromium, Mercury, Silver, and Vanadium were 0.007, 0.0004, 0.006, 0.010, and 0.006 mg/l, respectively.

- - No detection limits have been established.

TABLE C-9 DETECTION LIMITS FOR K102 SAMPLE SETS #4 AND #5

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics			
222	Acetone	3	3	0.010
1	Acetonitrile	30	30	0.100
2	Acrolein	30	30	0.100
3	Acrylonitrile	30	30	0.100
4	Benzene	1.5	1.5	0.005
5	Bromodichloromethane	1.5	1.5	0.005
6	Bromomethane	3	3	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	1.5	1.5	0.005
8	Carbon Disulfide	1.5	1.5	0.005
9	Chlorobenzene	1.5	1.5	0.005
10	2-Chloro-1,3-Butadiene	30	30	0.100
11	Chlorodibromomethane	1.5	1.5	0.005
12	Chloroethane	3	3	0.010
13	2-Chloroethylvinylether	3	3	0.010
14	Chloroform	1.5	1.5	0.005
15	Chloromethane	3	3	0.010
16	3-Chloropropene	30	30	0.100
17	1,2-Dibromo-3-Chloropropane	3	3	0.010
18	1,2-Dibromoethane	1.5	1.5	0.005
19	Dibromomethane	1.5	1.5	0.005
20	Trans-1,4-Dichloro-2-Butene	30	30	0.100
21	Dichlorodifluoromethane	3	3	0.010
22	1,1-Dichloroethane	1.5	1.5	0.005
23	1,2-Dichloroethane	1.5	1.5	0.005
24	1,1-Dichloroethene	1.5	1.5	0.005
25	Trans-1,2-Dichloroethene	1.5	1.5	0.005
26	1,2-Dichloropropane	1.5	1.5	0.005
27	Trans-1,3-Dichloropropene	1.5	1.5	0.005
28	cis-1,3,Dichloropropene	1.5	1.5	0.005
29	1,4-Dioxane	60	60	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	1.5	1.5	0.005
30	Ethyl Cyanide	30	30	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	30	30	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	15	15	0.050
33	Isobutyl Alcohol	60	60	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	3	3	0.010
34	Methyl ethyl ketone	3	3	0.010
229	Methyl isobutyl ketone	3	3	0.010
35	Methyl Methacrylate	30	30	0.100

TABLE C-9 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	30	30	0.100
38	Methylene Chloride	1.5	1.5	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	120	120	0.400
	Styrene	1.5	1.5	0.005
40	1,1,1,2-Tetrachloroethane	1.5	1.5	0.005
41	1,1,2,2-Tetrachloroethane	1.5	1.5	0.005
42	Tetrachloroethene	1.5	1.5	0.005
43	Toluene	1.5	1.5	0.005
44	Tribromomethane(bromoform)	1.5	1.5	0.005
45	1,1,1-Trichloroethane	1.5	1.5	0.005
46	1,1,2-Trichloroethane	1.5	1.5	0.005
47	Trichloroethene	1.5	1.5	0.005
48	Trichloromonofluoromethane	1.5	1.5	0.005
49	1,2,3-Trichloropropane	1.5	1.5	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	3	3	0.010
50	Vinyl Chloride	3	3	0.010
	Xylenes	1.5	1.5	0.005
	Semivolatile Organics			
51	Acenaphthalene	194	1	0.010
52	Acenaphthene	194	1	0.010
53	Acetophenone	388	2	0.020
54	2-Acetylaminofluorene	388	2	0.020
55	4-Aminobiphenyl	388	2	0.020
56	Aniline	194	1	0.010
57	Anthracene	194	1	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	194	1	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	970	5	0.050
	Benzoic Acid	980	5	0.010
62	Benzo(a)pyrene	194	1	0.010
63	Benzo(b)fluoranthene	194	1	0.010
64	Benzo(g,h,i) perylene	194	1	0.010
65	Benzo(k)fluoranthene	194	1	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	194	1	0.010
67	Bis(2-Chloroethoxy) methane	194	1	0.010
68	Bis(2-Chloroethyl) Ether	194	1	0.010
69	Bis(2-chloroisopropyl) ether	194	1	0.010
70	Bis(2-ethylhexyl) phthalate	194	1	0.010
71	4-Bromophenyl phenyl ether	194	1	0.010

TABLE C-9 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	194	1	0.010
73	2-Sec-Butyl-4,6-Dinitrophenol	970	5	0.050
74	p-Chloroaniline	194	1	0.010
75	Chlorobenzilate	NA	NA	NA
76	p-Chloro-m-cresol	194	1	0.010
77	2-Chloronaphthalene	194	1	0.010
78	2-Chlorophenol	194	1	0.010
	4-Chlorophenyl-phenyl ether	194	1	0.010
79	3-Chloropropionitrile	NA	NA	NA
80	Chrysene	194	1	0.010
81	Ortho-cresol	194	1	0.010
82	para-cresol	194	1	0.010
232	Cyclohexanone	ND	ND	ND
83	Dibenz(a,h)anthracene	194	1	0.010
	Dibenzofuran	194	1	0.010
84	Dibenzo(a,e,) Pyrene	NA	NA	NA
85	Dibenzo(a,i) Pyrene	NA	NA	NA
86	1,3-Dichlorobenzene	194	1	0.010
87	1,2-Dichlorobenzene	194	1	0.010
88	1,4-Dichlorobenzene	194	1	0.010
89	3,3'Dichlorobenzidine	380	2	0.020
90	2,4-Dichlorophenol	194	1	0.010
91	2,6-Dichlorophenol	ND	ND	ND
92	Diethyl phthalate	194	1	0.010
93	3,3'-Dimethoxybenzidine	194	1	0.010
94	p-Dimethylaminoazobenzene	388	2	0.020
95	3,3'-Dimethylbenzidine	ND	ND	ND
96	2,4-Dimethylphenol	194	1	0.010
97	Dimethyl Phthalate	194	1	0.010
98	Di-n-butyl phthalate	194	1	0.010
99	1,4-Dinitrobenzene	970	5	0.050
100	4,6-dinitro-o-cresol	980	5	0.050
101	2,4-Dinitrophenol	980	5	0.050
102	2,4-Dinitrotoluene	194	1	0.010
103	2,6-Dinitrotoluene	194	1	0.010
104	Di-n-octyl phthalate	194	1	0.010
105	Di-n-propylnitrosoamine	194	1	0.010
106	Diphenylamine (1)	388	2	0.020
107	1,2,-Diphenylhydrazine	970	5	0.050
108	Fluoranthene	194	1	0.010
109	Fluorene	194	1	0.010
110	Hexachlorobenzene	194	1	0.010
111	Hexachlorobutadiene	194	1	0.010
112	Hexachlorocyclopentadiene	194	1	0.010
113	Hexachloroethane	194	1	0.010
114	Hexachlorophene	NA	NA	NA

TABLE C-9 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND	ND	ND
116	Indeno(1,2,3,-cd) Pyrene	194	1	0.010
117	Isosafrole	388	2	0.020
	Isophorone	194	1	0.010
118	Methapyrilene	NA	NA	NA
119	3-Methylcholanthrene	388	2	0.020
120	4,4'-Methylene-bis-(2-chloroaniline)	388	2	0.020
36	Methyl Methanesulfonate	ND	ND	ND
	2-Methylnaphthalene	194	1	0.010
121	Naphthalene	194	1	0.010
122	1,4-Naphthoquinone	NA	NA	NA
123	1-Naphthylamine	970	5	0.050
124	2-Naphthylamine	970	5	0.050
	2-Nitroaniline	980	5	0.050
	3-Nitroaniline	980	5	0.050
125	p-Nitroaniline	980	5	0.050
126	Nitrobenzene	194	1	0.010
	2-Nitrophenol	194	1	0.010
127	4-Nitrophenol	980	5	0.050
128	N-Nitrosodi-n-butylamine	ND	ND	ND
129	N-Nitrosodiethylamine	ND	ND	ND
130	N-Nitrosodimethylamine	194	1	0.010
219	N-Nitrosodiphenylamine (1)	194	1	0.010
131	N-Nitrosomethylethylamine	194	1	0.020
132	N-Nitrosomorpholine	388	2	0.010
133	1-Nitrosopiperidine	194	1	0.010
134	N-Nitrosopyrrolidine	970	5	0.050
135	2-Methyl-5-nitroaniline	388	2	0.020
136	Pentachlorobenzene	ND	ND	ND
137	Pentachloroethane	NA	NA	NA
138	Pentachloronitrobenzene	1940	1	0.100
139	Pentachlorophenol	980	5	0.050
140	Phenacetin	388	2	0.020
141	Phenanthrene	194	1	0.010
142	Phenol	194	1	0.010
220	Phthalic Anhydride	ND	ND	ND
143	2-Picoline	194	1	0.010
144	Pronamide	ND	ND	ND
145	Pyrene	194	1	0.010
146	Resorcinol	NA	NA	NA
147	Safrole	970	5	0.050
148	1,2,4,5-Tetrachlorobenzene	388	2	0.020
149	2,3,4,6-Tetrachlorophenol	ND	ND	ND
150	1,2,4-Trichlorobenzene	194	1	0.010
151	2,4,5-Trichlorophenol	980	5	0.050
152	2,4,6-Trichlorophenol	194	1	0.010
153	Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-9 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition			
154	Antimony	1.5	1.5	0.015
155	Arsenic	1.0	1.0	0.010
156	Barium	0.2	0.2	0.002
157	Beryllium	0.1	0.10	0.001
158	Cadmium	0.5	0.5	0.005
159	Chromium	0.5	0.5	0.005
221	Hexavalent Chromium (mg/l)	0.01	0.01	0.010
160	Copper	0.4	0.4	0.004
161	Lead	0.5	0.5	0.005
162	Mercury	0.1	0.1	0.0002
163	Nickel	1.1+	0.9	0.009
164	Selenium	0.5	0.5	0.005
165	Silver	0.7	0.7	0.005
166	Thallium	1.0	1.0	0.010
167	Vanadium	0.4	0.3	0.003
168	Zinc	0.2	0.2	0.002
	Metals - TCLP (mg/l)			
154	Antimony	NOT ANALYZED	0.015	NOT ANALYZED
155	Arsenic		0.010	
156	Barium		0.002	
157	Beryllium		0.001	
158	Cadmium		0.005	
159	Chromium		0.005	
160	Copper		0.004	
161	Lead		0.005	
162	Mercury		0.0002	
163	Nickel		0.009	
164	Selenium		0.005	
165	Silver		0.007	
166	Thallium		0.100	
167	Vanadium		0.004	
168	Zinc		0.002	

TABLE C-9 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
	Inorganics			
169	Cyanide	-	-	0.01
170	Flouride	-	-	0.2
171	Sulfide	-	-	0.5
	Other Parameters			
	Chlorides	-	-	1
	Sulfates	-	-	5

* - No samples were taken for Sample Set #5.

(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

+ - The detection limit for sample set 5 for Nickel is 11 mg/kg.

- - No detection limit has been established.

TABLE C-10 DETECTION LIMITS FOR K102 SAMPLE SET #6

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics			
222	Acetone	3		0.010
1	Acetonitrile	30		0.100
2	Acrolein	30		0.100
3	Acrylonitrile	30		0.100
4	Benzene	1.5		0.005
5	Bromodichloromethane	1.5	NO	0.005
6	Bromomethane	3		0.010
223	n-Butyl Alcohol	NA		NA
7	Carbon Tetrachloride	1.5		0.005
8	Carbon Disulfide	1.5		0.005
9	Chlorobenzene	1.5	SAMPLES	0.005
10	2-Chloro-1,3-Butadiene	30		0.100
11	Chlorodibromomethane	1.5		0.005
12	Chloroethane	3		0.010
13	2-Chloroethylvinylether	3	TAKEN	0.010
14	Chloroform	1.5		0.005
15	Chloromethane	3		0.010
16	3-Chloropropene	30		0.100
17	1,2-Dibromo-3-Chloropropane	3		0.010
18	1,2-Dibromoethane	1.5		0.005
19	Dibromomethane	1.5		0.005
20	Trans-1,4-Dichloro-2-Butene	30		0.100
21	Dichlorodifluoromethane	3		0.010
22	1,1-Dichloroethane	1.5		0.005
23	1,2-Dichloroethane	1.5		0.005
24	1,1-Dichloroethene	1.5		0.005
25	Trans-1,2-Dichloroethene	1.5		0.005
26	1,2-Dichloropropane	1.5		0.005
27	Trans-1,3-Dichloropropene	1.5		0.005
28	cis-1,3,Dichloropropene	1.5		0.005
29	1,4-Dioxane	60		0.200
224	2-Ethoxyethanol	NA		NA
225	Ethyl Acetate	NA		NA
226	Ethylbenzene	1.5		0.005
30	Ethyl Cyanide	30		0.100
227	Ethyl Ether	NA		NA
31	Ethyl Methacrylate	30		0.100
214	Ethylene Oxide	NA		NA
32	Iodomethane	15		0.050
33	Isobutyl Alcohol	60		0.200
228	Methanol	NA		NA
	Methyl butyl ketone	3		0.010
34	Methyl ethyl ketone	3		0.010
229	Methyl isobutyl ketone	3		0.010
35	Methyl Methacrylate	30		0.100

TABLE C-10 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Volatile Organics (cont.)			
37	Methacrylonitrile	30		0.100
38	Methylene Chloride	1.5		0.005
230	2-Nitropropane	NA		NA
39	Pyridine	120		0.400
	Styrene	1.5		0.005
40	1,1,1,2-Tetrachloroethane	1.5		0.005
41	1,1,2,2-Tetrachloroethane	1.5		0.005
42	Tetrachloroethene	1.5		0.005
43	Toluene	1.5		0.005
44	Tribromomethane(bromoform)	1.5		0.005
45	1,1,1-Trichloroethane	1.5		0.005
46	1,1,2-Trichloroethane	1.5		0.005
47	Trichloroethene	1.5		0.005
48	Trichloromonofluoromethane	1.5		0.005
49	1,2,3-Trichloropropane	1.5		0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA		NA
	Vinyl Acetate	3	NO	0.010
50	Vinyl Chloride	3		0.010
	Xylenes	1.5		0.005
	Semivolatile Organics		SAMPLES	
51	Acenaphthalene	184		10
52	Acenaphthene	184		10
53	Acetophenone	368	TAKEN	20
54	2-Acetylaminofluorene	368		20
55	4-Aminobiphenyl	368		20
56	Aniline	184		10
57	Anthracene	184		10
58	Aramite	NA		NA
59	Benzo(a)anthracene	184		10
218	Benzal Chloride	NA		NA
60	Benzenethiol	ND		ND
61	Benzidine	920		50
	Benzoic Acid	918		10
62	Benzo(a)pyrene	184		10
63	Benzo(b)fluoranthene	184		10
64	Benzo(g,h,i) perylene	184		10
65	Benzo(k)fluoranthene	1840		10
66	p-Benzoquinone	ND		ND
	Benzyl Alcohol	184		10
67	Bis(2-Chloroethoxy) methane	184		10
68	Bis(2-Chloroethyl) Ether	184		10
69	Bis(2-chloroisopropyl) ether	184		10
70	Bis(2-ethylhexyl) phthalate	184		10
71	4-Bromophenyl phenyl ether	184		10

TABLE C-10 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
72	Butyl benzyl phthalate	184		10
73	2-Sec-Butyl-4,6-Dinitrophenol	920		50
74	p-Chloroaniline	184		10
75	Chlorobenzilate	NA		NA
76	p-Chloro-m-cresol	184		10
77	2-Chloronaphthalene	184		10
78	2-Chlorophenol	184		10
	4-Chlorophenyl-phenyl ether	184		10
79	3-Chloropropionitrile	NA		NA
80	Chrysene	184		10
81	Ortho-cresol	184		10
82	para-cresol	184		10
232	Cyclohexanone	ND		ND
83	Dibenz(a,h)anthracene	184		10
	Dibenzofuran	184		10
84	Dibenzo(a,e,) Pyrene	NA		NA
85	Dibenzo(a,i) Pyrene	NA		NA
86	1,3-Dichlorobenzene	184		10
87	1,2-Dichlorobenzene	184		10
88	1,4-Dichlorobenzene	184		10
89	3,3'Dichlorobenzidine	366		20
90	2,4-Dichlorophenol	184	NO	10
91	2,6-Dichlorophenol	ND		ND
92	Diethyl phthalate	184		10
93	3,3'-Dimethoxybenzidine	184		10
94	p-Dimethylaminoazobenzene	368	SAMPLES	20
95	3,3'-Dimethylbenzidine	ND		ND
96	2,4-Dimethylphenol	184		10
97	Dimethyl Phthalate	184		10
98	Di-n-butyl phthalate	184	TAKEN	10
99	1,4-Dinitrobenzene	920		50
100	4,6-dinitro-o-cresol	918		50
101	2,4-Dinitrophenol	918		50
102	2,4-Dinitrotoluene	184		10
103	2,6-Dinitrotoluene	184		10
104	Di-n-octyl phthalate	184		10
105	Di-n-propylnitrosoamine	184		10
106	Diphenylamine (1)	368		20
107	1,2,-Diphenylhydrazine	920		50
108	Fluoranthene	184		10
109	Fluorene	184		10
110	Hexachlorobenzene	184		10
111	Hexachlorobutadiene	184		10
112	Hexachlorocyclopentadiene	184		10
113	Hexachloroethane	184		10
114	Hexachlorophene	NA		NA

TABLE C-10 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Semivolatile Organics (cont.)			
115	Hexachloropropene	ND		ND
116	Indeno(1,2,3,-cd) Pyrene	184		10
117	Isosafrole	368		20
	Isophorone	184		10
118	Methapyrilene	NA		NA
119	3-Methylcholanthrene	368		20
120	4,4'-Methylene-bis-(2-chloroaniline)	368		20
36	Methyl Methanesulfonate	ND		ND
	2-Methylnaphthalene	184		10
121	Naphthalene	184		10
122	1,4-Naphthoquinone	NA		NA
123	1-Naphthylamine	920		50
124	2-Naphthylamine	920		50
	2-Nitroaniline	918		50
	3-Nitroaniline	918		50
125	p-Nitroaniline	918		50
126	Nitrobenzene	184		10
	2-Nitrophenol	184		10
127	4-Nitrophenol	918		50
128	N-Nitrosodi-n-butylamine	ND		ND
~~129~~	~~N-Nitrosodiethylamine~~	~~ND~~		~~ND~~
130	N-Nitrosodimethylamine	184		10
219	N-Nitrosodiphenylamine (1)	184		10
131	N-Nitrosomethylethylamine	184	NO	10
132	N-Nitrosomorpholine	368		20
133	1-Nitrosopiperidine	184		10
134	N-Nitrosopyrrolidine	920		50
135	5-Nitro-o-toluidine	368	SAMPLES	20
136	Pentachlorobenzene	ND		ND
137	Pentachloroethane	NA		NA
138	Pentachloronitrobenzene	1840		100
139	Pentachlorophenol	918	TAKEN	50
140	Phenecetin	368		20
141	Phenanthrene	184		10
142	Phenol	184		10
220	Phthalic Anhydride	ND		ND
143	2-Picoline	184		10
144	Pronamide	ND		ND
145	Pyrene	184		10
146	Resorcinol	NA		NA
147	Safrole	920		50
148	1,2,4,5-Tetrachlorobenzene	368		20
149	2,3,4,6-Tetrachlorophenol	ND		ND
150	1,2,4-Trichlorobenzene	184		10
151	2,4,5-Trichlorophenol	918		50
152	2,4,6-Trichlorophenol	184		10
153	Tris(2,3-dibromopropyl) phosphate	ND		ND

TABLE C-10 (Continued)

	BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
	Metals - Total Composition			
154	Antimony	1.5		0.015
155	Arsenic	1.0		0.010
156	Barium	0.2		0.002
157	Beryllium	0.1		0.001
158	Cadmium	0.5		0.005
159	Chromium	0.5		0.005
221	Hexavalent Chromium (mg/l)	0.01		0.010
160	Copper	0.4		0.004
161	Lead	0.5		0.005
162	Mercury	0.1		0.0002
163	Nickel	11		0.009
164	Selenium	0.5		0.005
165	Silver	0.7		0.005
166	Thallium	0.1		0.010
167	Vanadium	0.3		0.003
168	Zinc	0.2		0.002
	Metals - TCLP (mg/l)			
154	Antimony	NOT ANALYZED	NO SAMPLES TAKEN	NOT ANALYZED
155	Arsenic			
156	Barium			
157	Beryllium			
158	Cadmium			
159	Chromium			
160	Copper			
161	Lead			
162	Mercury			
163	Nickel			
164	Selenium			
165	Silver			
166	Thallium			
167	Vanadium			
168	Zinc			
	Inorganics			
169	Cyanide	-		0.01
170	Flouride	-		0.2
171	Sulfide	-		0.5
	Other Parameters			
	Chlorides	-		1
	Sulfates	-		5

---

(1) - Cannot be separated from N-Nitrosodipenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

- - Detection have not been established.

APPENDIX D

Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: Acetone

Sample Set	1 Kiln Ash Concentration (mg/kg)	2+ Percent Recovery	3* Accuracy Correction Factor	4 Corrected Concentration (mg/kg)	5 Log Transform
1	0.010	106	1.0	0.010	-4.605
2	0.010	106	1.0	0.010	-4.605
3	0.010	106	1.0	0.010	-4.605
			x =	0.010	y = -4.605
					s = 0.000

1 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 5-7.

2 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 6-15.
+ - Values are actually the average of all volatiles.

3 - Accuracy Correction Factor = 100 / Percent Recovery.
* - Corrected concentration cannot be below the detection limit; therefore, the accuracy factor is adjusted to 1.0.

4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF
= 0.010 X 2.8
= 0.028 mg/kg

APPENDIX D

Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: Toluene

Sample Set	1 Kiln Ash Concentration (mg/kg)	2 Percent Recovery	3* Accuracy Correction Factor	4 Corrected Concentration (mg/kg)	5 Log Transform
1	0.005	106	1.0	0.005	-5.298
2	0.005	106	1.0	0.005	-5.298
3	0.005	106	1.0	0.005	-5.298
			x =	0.005	y = -5.298
					s = 0.000

1 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 5-7.

2 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 6-15.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

* - Corrected concentration cannot be below the detection limit; therefore, the accuracy factor is adjusted to 1.0.

4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF
= 0.005 X 2.8
= 0.014 mg/kg

APPENDIX D

Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: Aniline

Sample Set	1 Kiln Ash Concentration (mg/kg)	2+ Percent Recovery	3 Accuracy Correction Factor	4 Corrected Concentration (mg/kg)	5 Log Transform
1	0.420	40	2.5	1.05	0.049
2	0.420	40	2.5	1.05	0.049
3	0.420	40	2.5	1.05	0.049
			x =	1.05	y = 0.049
					s = 0.000

1 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 5-7.

2 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 6-16.
+ - Values are actually the average of all semivolatiles.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF
= 1.05 X 2.8
= 2.940 mg/kg

APPENDIX D

Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: 2-Nitroaniline

Sample Set	Kiln Ash 1 Concentration (mg/kg)	Percent 2+ Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/kg)		Log 5 Transform
1	2.0	40	2.50	5.000		1.609
2	2.0	40	2.50	5.000		1.609
3	2.0	40	2.50	5.000		1.609
			x =	5.000	y =	1.609
					s =	0.000

1 - Obtained from the Onsite Engineering Report for John Zink Company for K101, Table 5-7.

2 - Obtained from the Onsite Engineering Report for John Zink Company for K101, Table 6-16.

+ - Values are actually the average of all semivolatiles.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF
= 5.000 X 2.80
= 14.000 mg/kg

APPENDIX D

Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: Toluene

Sample Set	1 Kiln Ash Concentration (mg/kg)	2 Percent Recovery	3* Accuracy Correction Factor	4 Corrected Concentration (mg/kg)	5 Log Transform
1	1.5	112	1.0	1.500	0.405
2	1.5	112	1.0	1.500	0.405
3	1.5	112	1.0	1.500	0.405
4	1.5	112	1.0	1.500	0.405
			x =	1.500	y = 0.405
					s = 0.000

1 - Obtained from the Onsite Engineering Report, John Zink Company for K102, Table 5-7.
2 - Obtained from the Onsite Engineering Report, John Zink Company for K102, Table 6-15.
3 - Accuracy Correction Factor = 100 / Percent Recovery.
  * - Corrected concentration cannot be below the detection limit; therefore, the accuracy factor is adjusted to 1.0.
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.
5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF
= 1.500 X 2.8
= 4.200 mg/kg

APPENDIX D

Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: Total Xylenes

Sample Set	1 Kiln Ash Concentration (mg/kg)	2+ Percent Recovery	3* Accuracy Correction Factor	4 Corrected Concentration (mg/kg)	5 Log Transform
1	1.5	112	1.0	1.500	0.405
2	1.5	112	1.0	1.500	0.405
3	1.5	112	1.0	1.500	0.405
4	1.5	112	1.0	1.500	0.405
			x =	1.500	y = 0.405
					s = 0.000

1 - Obtained from the Onsite Engineering Report, John Zinc Company for K102, Table 5-7.

2 - Obtained from the Onsite Engineering Report, John Zinc Company for K102, Table 6-15.

+ - Values are actually the average of all volatiles.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

* - Corrected concentration cannot be below the detection limit;
therefore, the accuracy factor is adjusted to 1.0.

4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF
= 1.500 X 2.8
= 4.200 mg/kg

APPENDIX D

Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: 2-Nitrophenol

Sample Set	Kiln Ash Concentration (mg/kg) 1	Percent Recovery 2+	Accuracy Correction Factor 3	Corrected Concentration (mg/kg) 4	Log Transform 5
1	1.0	21	4.76	4.760	1.560
2	1.0	21	4.76	4.760	1.560
3	1.0	21	4.76	4.760	1.560
4	1.0	21	4.76	4.760	1.560
			x =	4.760 y =	1.560
				s =	0.000

1 - Obtained from the Onsite Engineering Report for John Zink Company for K102, Table 5-3 through 5-6.

2 - Obtained from the Onsite Engineering Report for John Zink Company for K102, Table 6-16.
+ - Values are actually the value for the isomer 4-Nitrophenol.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF
= 4.760 X 2.80
= 13.328 mg/kg

APPENDIX D

Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: Phenol

Sample Set	1 Kiln Ash Concentration (mg/kg)	2 Percent Recovery	3 Accuracy Correction Factor	4 Corrected Concentration (mg/kg)	5 Log Transform
1	1.0	61	1.64	1.640	0.495
2	1.0	61	1.64	1.640	0.495
3	1.0	61	1.64	1.640	0.495
4	1.0	61	1.64	1.640	0.495
			x =	1.640	y = 0.495
					s = 0.000

1 - Obtained from the Onsite Engineering Report, John Zinc Company, Table 5-7.
2 - Obtained from the Onsite Engineering Report, John Zinc Company, Table 6-16.
3 - Accuracy Correction Factor = 100 / Percent Recovery.
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.
5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Effluent Mean X VF
= 1.640 X 2.8
= 4.592 mg/kg

APPENDIX D

Calculation of Treatment Standards for K101 Wastewaters

Constituent: 2-Nitroaniline

Sample Set	Effluent Concentration (mg/l) 1	Percent 2+ Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/l)	Log 5 Transform
1	0.050	53	1.89	0.095	-2.354
2	0.050	53	1.89	0.095	-2.354
3	0.050	53	1.89	0.095	-2.354
4	0.050	53	1.89	0.095	-2.354
			x =	0.095	y = -2.354
					s = 0.000

1 - Obtained from the Onsite Engineering Report for John Zink Company, Tables 5-3 to 5-6.

2 - Obtained from the Onsite Engineering Report for John Zink Company, Table 6-19.

+ - Values are actually the average of all semivolatiles.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF
VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Effluent Mean X VF
= 0.095 X 2.8
= 0.266 mg/l

APPENDIX D

Calculation of Treatment Standards for K102 Wastewaters

Constituent: 2-Nitrophenol

Sample Set	Effluent Concentration (mg/l) 1	Percent Recovery 2+	Accuracy Correction Factor 3*	Corrected Concentration (mg/l) 4	Log Transform 5
1	0.010	113	1.0	0.010	-4.605
2	0.010	113	1.0	0.010	-4.605
3	0.010	113	1.0	0.010	-4.605
4	0.010	113	1.0	0.010	-4.605
5	0.010	113	1.0	0.010	-4.605
6	0.010	113	1.0	0.010	-4.605
			x =	0.010	y = -4.605
					s = 0

1 - Obtained from the Onsite Engineering Report for John Zink Company, Tables 5-3 to 5-8.

2 - Obtained from the Onsite Engineering Report for John Zink Company, Table 6-19.

+ - Values are actually for the isomer 4-nitrophenol.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

* - Corrected concentration cannot be below the detection limit; therefore, the accuracy factor is adjusted to 1.0.

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF
VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Effluent Mean X VF
= 0.010 X 2.80
= 0.028 mg/l

APPENDIX D

Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Arsenic

Sample Set	Effluent Concentration (mg/l) [1]	Percent Recovery [2]	Accuracy Correction Factor [3]	Corrected Concentration (mg/l) [4]	Log Transform [5]
1	0.415	143	0.70	0.291	-1.234
2	2.000	143	0.70	1.400	0.336
3	0.513	143	0.70	0.359	-1.024
4	0.418	143	0.70	0.293	-1.228
5	0.440	143	0.70	0.308	-1.178
			x =	0.530	y = -0.866
					s = 0.677

1 - Obtained from the Onsite Engineering Report for D004, Table 5-15
2 - Obtained from the Onsite Engineering Report for D004, Table 6-14
3 - Accuracy Correction Factor = 100 / Percent Recovery.
4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.
5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

C_{99} = exp (y + 2.33s)

where y = the mean of the log transforms
s = the standard deviation of the log transforms.

Therefore, C_{99} = exp (-0.866 + 2.33(0.677))
= exp (0.711)
= 2.036

and VF = C_{99} / x

where x = the mean of the corrected effluent concentrations.

Therefore, VF = C_{99} / x
= 2.036 / 0.530
= 3.842

Treatment Standard = Corrected Effluent Mean X VF
= 0.530 X 3.842
= 2.036 mg/l

APPENDIX D

Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Cadmium

Sample Set	Effluent Concentration (mg/l) 1	Percent 2 Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/l)	Log 5 Transform
1	0.080	94	1.06	0.085	-2.465
2	0.080	94	1.06	0.085	-2.465
3	0.080	94	1.06	0.085	-2.465
4	0.080	94	1.06	0.085	-2.465
5	0.080	94	1.06	0.085	-2.465
			x =	0.085	y = -2.465
					s = 0.000

---

1 - Obtained from the Onsite Engineering Report for D004, Table 5-15

2 - Obtained from the Onsite Engineering Report for D004, Table 6-14

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

$C_{99} = \exp(y + 2.33s)$

where y = the mean of the log transforms
s = the standard deviation of the log transforms.

Therefore, $C_{99} = \exp(-2.465 + 2.33(0.0))$
$= \exp(-2.465)$
$= 0.085$

and $VF = C_{99} / x$
where x = the mean of the corrected effluent concentrations.

Therefore, $VF = C_{99} / x$
$= 0.085 / 0.085$
$= 1.0$

A variability factor of one was not used in calculating the treatment standards. The variability factor of 2.80 was substituted for the value 1.

Treatment Standard = Corrected Effluent Mean X VF
= 0.085 X 2.80
= 0.238 mg/l

APPENDIX D

Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Lead

Sample Set	Effluent Concentration (mg/l) 1	Percent Recovery 2	Accuracy Correction Factor 3	Corrected Concentration (mg/l) 4	Log Transform 5
1	0.005	84	1.19	0.006	-5.116
2	0.029	84	1.19	0.035	-3.352
3	0.025	84	1.19	0.030	-3.507
4	0.010	84	1.19	0.012	-4.423
5	0.025	84	1.19	0.030	-3.507
			x =	0.023 y =	-3.981
				s =	0.763

1 - Obtained from the Onsite Engineering Report for D004, Table 5-15

2 - Obtained from the Onsite Engineering Report for D004, Table 6-14

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

$C_{99} = \exp(y + 2.33s)$

where y = the mean of the log transforms
s = the standard deviation of the log transforms.

Therefore, $C_{99} = \exp(-3.981 + 2.33(0.763))$
$= \exp(-2.203)$
$= 0.110$

and $VF = C_{99} / x$
where x = the mean of the corrected effluent concentrations.

Therefore, $VF = C_{99} / x$
$= 0.110 / 0.023$
$= 4.783$

Treatment Standard = Corrected Effluent Mean X VF
= 0.023 X 4.783
= 0.110 mg/l

APPENDIX D

Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Mercury

Sample Set	Effluent Concentration (mg/l) [1]	Percent Recovery [2]	Accuracy Correction Factor [3]	Corrected Concentration (mg/l) [4]	Log Transform [5]
1	0.001	95	1.05	0.001	-6.908
2	0.004	95	1.05	0.004	-5.521
3	0.009	95	1.05	0.009	-4.711
4	0.004	95	1.05	0.004	-5.521
5	0.006	95	1.05	0.006	-5.116
			x =	0.005	y = -5.555
					s = 0.827

---

1 - Obtained from the Onsite Engineering Report for D004, Table 5-15

2 - Obtained from the Onsite Engineering Report for D004, Table 6-14

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

$C_{99} = \exp(y + 2.33s)$

where y = the mean of the log transforms
s = the standard deviation of the log transforms.

Therefore, $C_{99} = \exp(-5.555 + 2.33(0.827))$
$= \exp(-3.628)$
$= 0.027$

and $VF = C_{99} / x$

where x = the mean of the corrected effluent concentrations.

Therefore, $VF = C_{99} / x$
$= 0.027 / 0.005$
$= 5.400$

Treatment Standard = Corrected Effluent Mean X VF
= 0.005 X 5.400
= 0.027 mg/l

APPENDIX E

METHOD OF MEASUREMENT FOR THERMAL CONDUCTIVITY

The comparative method of measuring thermal conductivity has been proposed as an ASTM test method under the name "Guarded, Comparative, Longitudinal Heat Flow Technique." A thermal heat flow circuit is used that is the analog of an electrical circuit with resistances in series. A reference material is chosen to have a thermal conductivity close to that estimated for the sample. Reference standards (also known as heat meters) having the same cross-sectional dimensions as the sample are placed above and below the sample. An upper heater, a lower heater, and a heat sink are added to the "stack" to complete the heat flow circuit. See Figure E-1.

The temperature gradients (analogous to potential differences) along the stack are measured with type K (chromel/alumel) thermocouples placed at known separations. The thermocouples are placed into holes or grooves in the references and also in the sample whenever the sample is thick enough to accommodate them.

For molten samples, pastes, greases, and other materials that must be contained, the material is placed into a cell consisting of a top and bottom of Pyrex 7740 and a containment ring of marinite. The sample is 2 inches in diameter and 0.5 inch thick. Thermocouples are not placed into the sample; rather, the temperatures measured in the Pyrex disks are extrapolated to give the temperature at the top and bottom surfaces of the sample material. The Pyrex disks also serve as the thermal conductivity reference material.

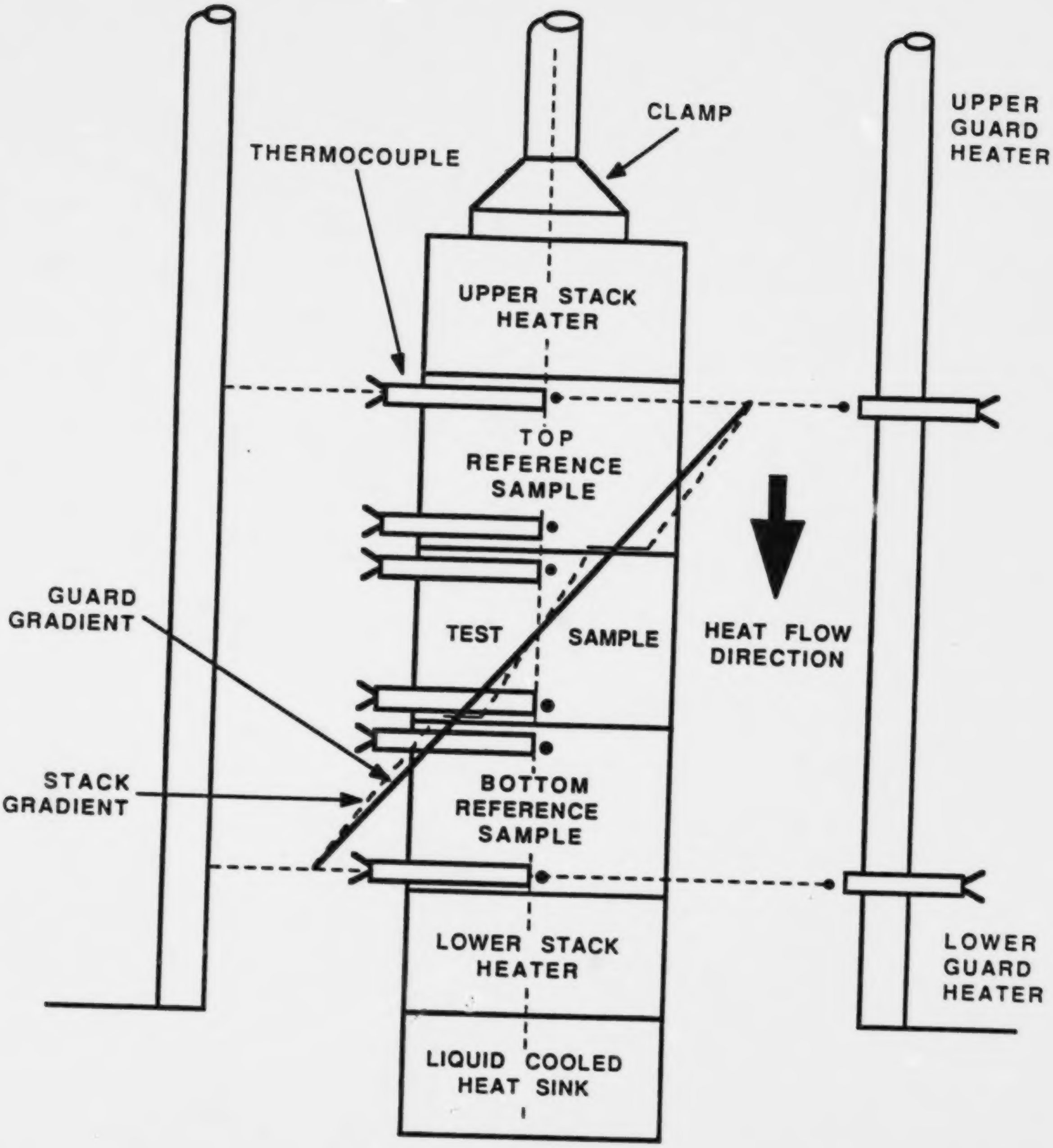
CLAMP
THERMOCOUPLE
UPPER GUARD HEATER
UPPER STACK HEATER
TOP REFERENCE SAMPLE
TEST SAMPLE
HEAT FLOW DIRECTION
GUARD GRADIENT
STACK GRADIENT
BOTTOM REFERENCE SAMPLE
LOWER STACK HEATER
LOWER GUARD HEATER
LIQUID COOLED HEAT SINK

FIGURE E-1 SCHEMATIC DIAGRAM OF THE COMPARATIVE METHOD

The stack is clamped with a reproducible load to ensure intimate contact between the components. To produce a linear flow of heat down the stack and reduce the amount of heat that flows radially, a guard tube is placed around the stack and the intervening space is filled with insulating grains or powder. The temperature gradient in the guard is matched to that in the stack to further reduce radial heat flow.

The comparative method is a steady-state method of measuring thermal conductivity. When equilibrium is reached, the first flux (analogous to current flow) down the stack can be determined from the references. The heat into the sample is given by

$$Q_{in} = \lambda_{top}(dT/dx)_{top}$$

and the heat out of the sample is given by

$$Q_{out} = \lambda_{bottom}(dT/dx)_{bottom}$$

where

λ = thermal conductivity

dT/dx = temperature gradient

and top refers to the upper reference, while bottom refers to the lower reference. If the heat was confined just to flow down the stack, then Q_{in} and Q_{out} would be equal. If Q_{in} and Q_{out} are in reasonable agreement, the average heat flow is calculated from

$$Q = (Q_{in} + Q_{out})/2.$$

The sample thermal conductivity is then found from

$$\lambda_{sample} = Q/(dT/dx)_{sample}.$$

The result for the K102 activated charcoal waste tested is given in Table E-1. The sample was held at an average temperature of 42°C, with a 53°C temperature drop across the sample for approximately 20 hours before the temperature profile became steady and the conductivity was measured. At the conclusion of the test, it appeared that some "drying" of the sample had occurred.

The result for the K101 waste tested is given in Table E-1. The sample was held at an average temperature of 39°C, with a 39°C temperature drop across the sample for approximately 4 hours before the temperature profile became steady and the conductivity was measured. At the conclusion of the test, it appeared that some "drying" of the sample had occurred. Bubbles had formed in the sample and had migrated to the top of the sample in contact with the upper reference. Approximately 15 percent of the upper Pyrex reference was not in contact with the sample when thermal equilibrium was reached. Thus, the conductivity given in Table E-1 may be low by 5 to 10 percent.

Table E-1 The Results of the Measurement of the Thermal Conductivity Using the Comparative Method

Sample	Temperature	Thermal conductivity
	(°C)	(W/mK)*
K101 waste	39	.273
K102 activated charcoal waste	42	.136

*1 W/mK = 6.933 Btu in/h ft^2 °F = .5778 Btu/h ft °F.

APPENDIX F

CONTINUOUS EMISSIONS MONITORING REPORT AND STRIP CHARTS FOR ENGINEERING SITE VISIT

Results of Arsenic Emissions Sampling and Continuous Emissions Monitoring for K101 and K102 Waste Incineration At John Zink Company, Tulsa, OK

RECEIVED
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Jacobs Engineering Group

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Radian Corporation
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February 5, 1988

Arsenic Emissions Sampling and Continuous Emissions Monitoring At John Zink

1.0 INTRODUCTION

2.0 ARSENIC EMISSIONS SAMPLING

3.0 SAMPLE ANALYSIS

4.0 ARSENIC SAMPLING RESULTS

5.0 CONTINUOUS EMISSIONS MONITORING

APPENDIX: TEST SUMMARIES AND RAW DATA FROM ARSENIC SAMPLING

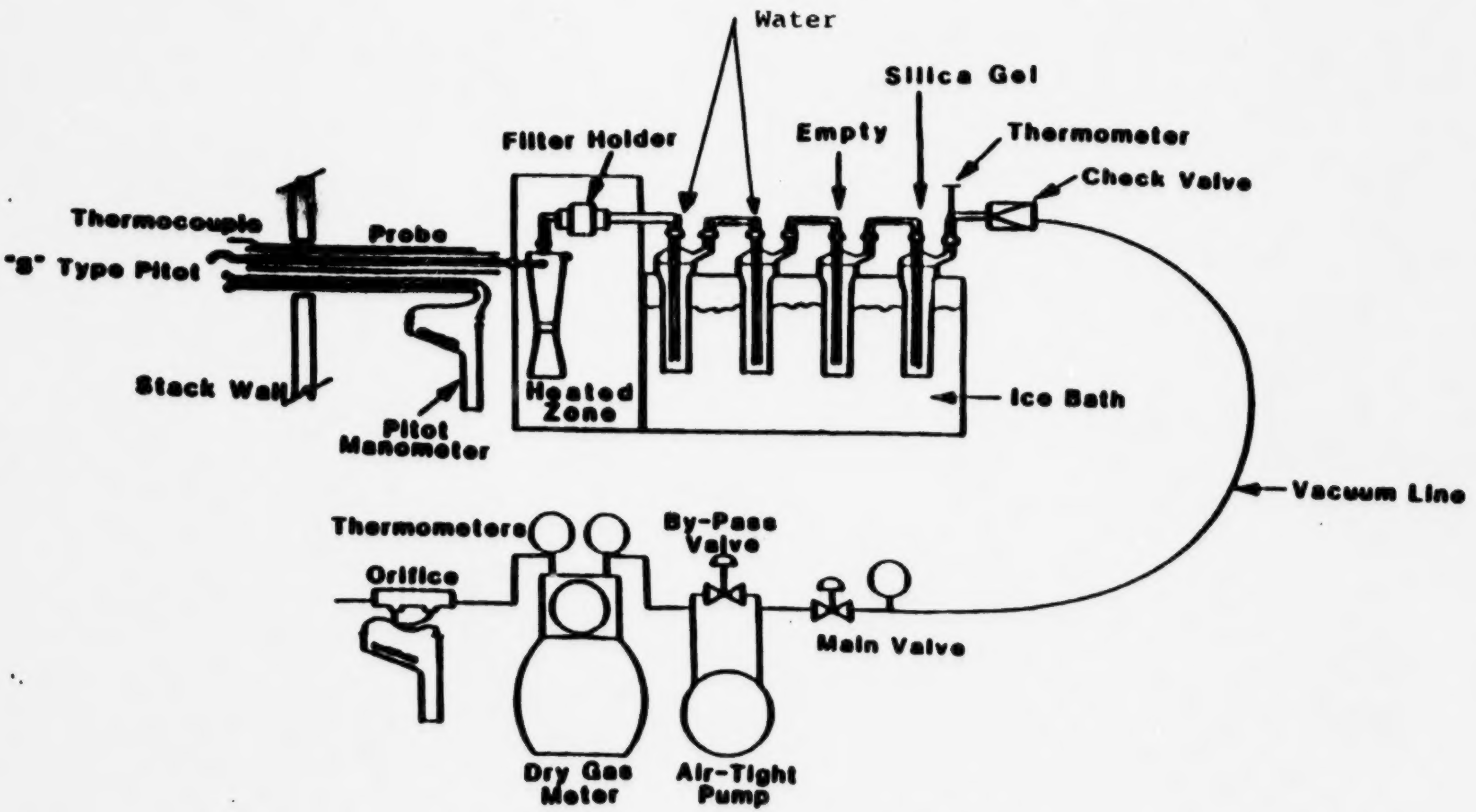
1.0 INTRODUCTION

Radian Corporation was contracted by Versar, Inc. to provide arsenic emissions sampling and continuous emissions monitoring at the John Zink Company's Tulsa, Oklahoma facility during the week of December 1, 1987. This work was performed in association with the EPA's program to develop treatment standards for wastes subject to land disposal restrictions. Radian Corporation's sampling efforts were conducted under the direction of Darrell Doerle and coordinated with the project manager, Mr. Robert Morton, of the Jacobs Engineering Group, Inc. The purpose of the emissions sampling was to monitor arsenic emissions created by incineration of the arsenic containing hazardous waste K102. The continuous emissions monitoring provided documentation of CO, CO_2, O_2, and total hydrocarbon emissions from the afterburner during incineration of wastes K102 and K101. The following is a brief discussion of the sampling and analytical procedures used as well as presentation of the results.

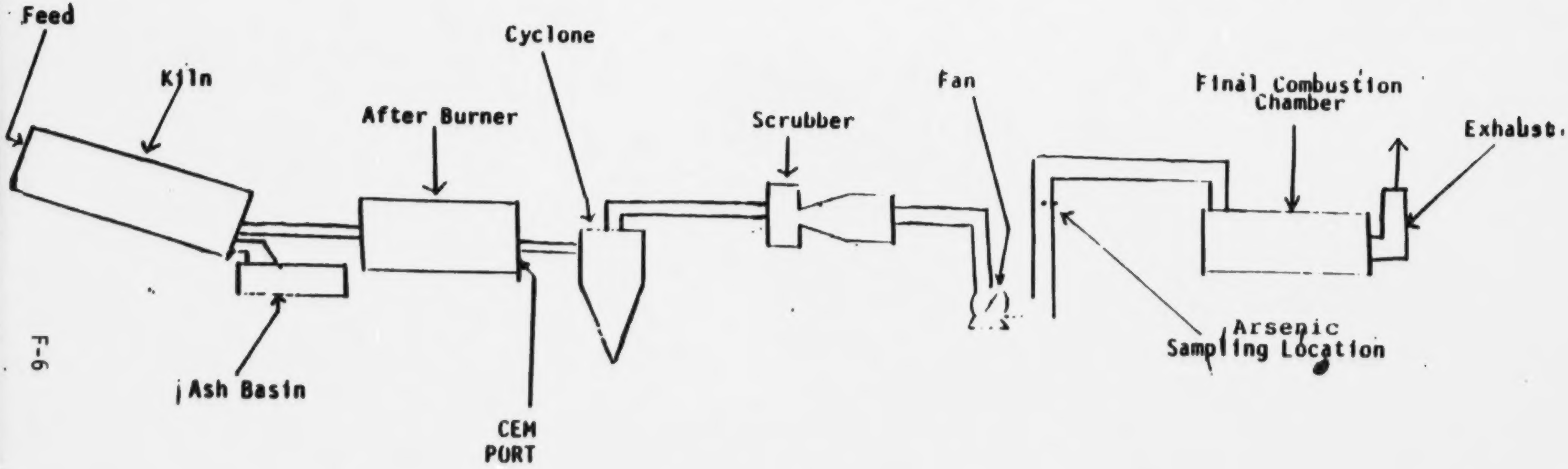
2.0 ARSENIC EMISSIONS SAMPLING

Three flue gas (emissions) samples were taken during the incineration of waste K102 for the determination of arsenic emissions. Total arsenic emissions are reported in the form of arsenic trioxide at the request of the State of Oklahoma. Samples were taken in accordance with protocols delineated in EPA Method 108 (Code of Federal Regulations Part 61, Appendix B).

Pallflex filters (type 2500 QAT-UP) were used for particulate phase collection of arsenic. These filters were selected for their low metals content as well as applicability to EPA Method 5 particulate sampling. Filter temperature was maintained at $248^{0} \pm 25^{0}$F for all samples. An effort was made to keep filter temperatures at the hotter end of the allowable range due to the low stack temperature and high moisture content. Figure 1-1 illustrates the sampling train that was used.


Water
Silica Gel
Filter Holder
Empty
Thermometer
Check Valve
Thermocouple
Probe
"S" Type Pitot
Stack Wall
Heated Zone
Ice Bath
Pitot Manometer
Vacuum Line
Thermometers
By-Pass Valve
Orifice
Main Valve
Dry Gas Meter
Air-Tight Pump

Components of the EPA Method 108 sampling train


Feed
Kiln
After Burner
Cyclone
Scrubber
Fan
Final Combustion Chamber
Exhaust
Ash Basin
CEM PORT
Arsenic Sampling Location

Gas Flow Schematic

Samples were taken in a twelve inch vertical duct located approximately 30 feet downstream of the scrubber outlet and 12 feet upstream of the final combustion chamber (Figure 1-2). Access to the gas stream was through two three inch ports set at 90° to each other and located eight feet downstream, three feet upstream from the nearest gas flow disturbance. Six points were sampled per port for five minutes each (60 minute test) for each of the three emissions samples that were collected. A schematic of the test matrix is shown in Figure 1-3.

At the beginning of the incineration test burn, there was a three hour supply of K102 waste for incinerator feed. In order to allow for time between collection of emissions samples and possible sampling problems, collection of the second sample was started halfway through collection of the first sample (at the port change). Collection of the third emission sample began following completion of the second sample.

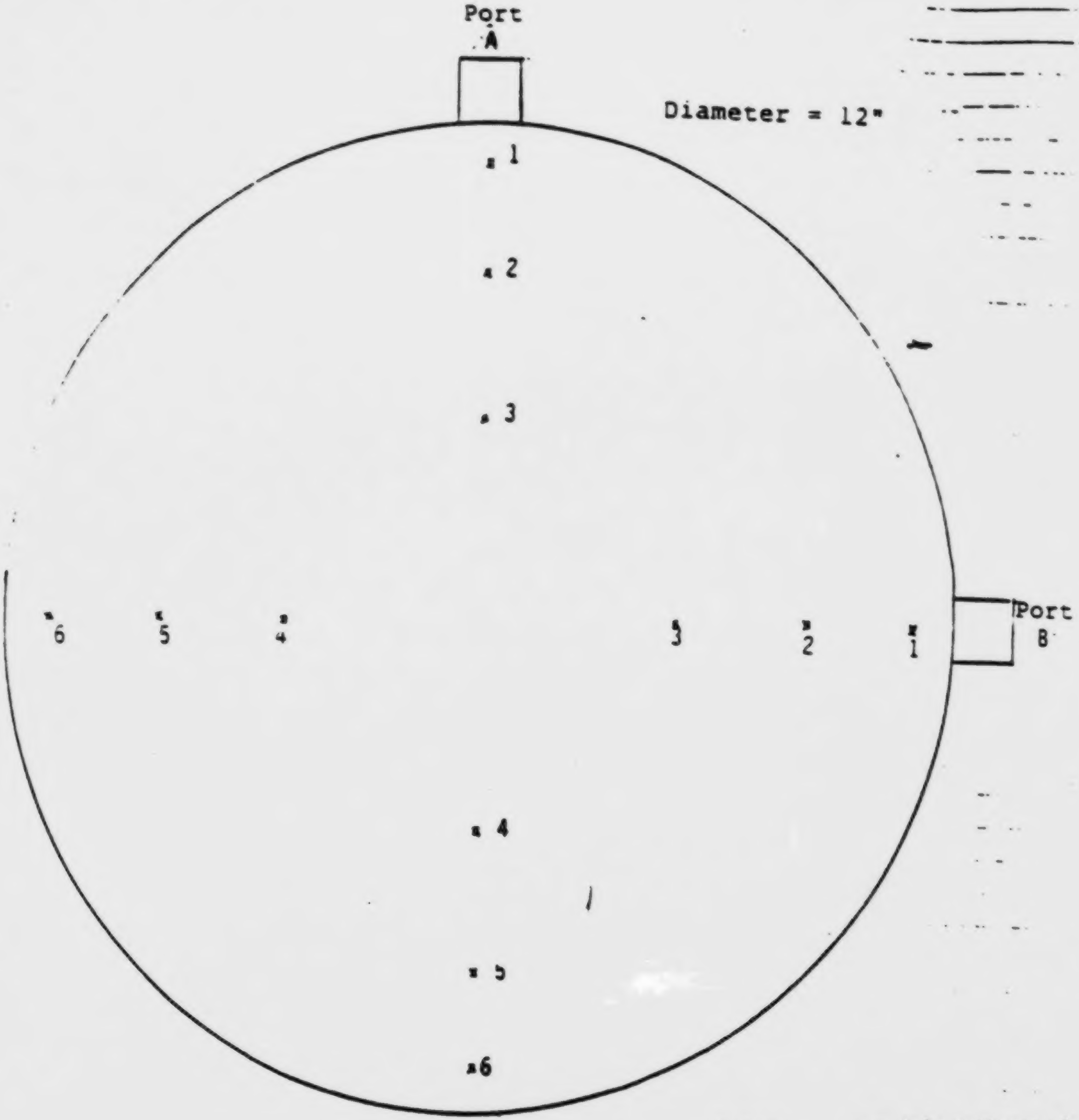
After sample collection the sampling train impingers were weighed for gravimetric moisture determination. The trains were then recovered in the following three components:

1) 0.1N NaOH rinses of probe, nozzle, and front half glassware;
2) filter;
3) back half impinger catch and 0.1N NaOH rinses of back half glassware.

Recovery containers were sealed, labeled, and logged into a master sample log book.

3.0 SAMPLE ANALYSIS

Samples to be analyzed for arsenic were taken to Carla Lance of National Analytical Laboratories (NAL) in Tulsa, Oklahoma. Due to the high amount of arsenic found in the samples, NAL performed inductively coupled argon plasma spectroscopy (ICAP) to provide higher resolution over a wider range of concentrations than would be possible by atomic absorption


Port
A
Diameter = 12"
1
2
3
4
5
6
6
5
4
3
2
1
Port
B

Point	Distance to Wall
1	0.5"
2	1.75"
3	3.6"
4	8.4"
5	10.25"
6	11.5"

Cross Sectional Schematic
of Emission Sampling Location

spectroscopy. Prior to analysis front half fractions were combined into one fraction, as were back half fractions. Analysis was then performed to determine total front half arsenic and total back half arsenic for each of the three samples collected.

4.0 ARSENIC SAMPLING RESULTS

The results of the arsenic testing can be found in Table 3-1. Complete test summaries and the raw data are found in the appendix. In calculating arsenic trioxide emissions from total arsenic emissions, it was assumed all arsenic was oxidized to As_2O_3 in the final combustion chamber. As shown in the table, the arsenic trioxide emission rate ranged from 0.0067 to 0.0139 kg/hr. The following two factors may have contributed to the apparent rise in arsenic emissions rates over time:

1) Feed of K102 waste to the incinerator began approximately 20 minutes after the stack samplers were instructed to begin collection of the first arsenic emissions sample; however, the emission rates were calculated based on the total time period for arsenic sample collection;

2) Scrubber water was recycled without addition of make-up water during the entire emission sampling period for K102 waste.

5.0 CONTINUOUS EMISSIONS MONITORING

Continuous emission monitoring was performed at the afterburner outlet location for O_2, CO_2, CO, and total hydrocarbons (THC). The sampling location is shown on Figure 1-2. The continuous monitoring was performed for the duration of the test burns of K102 waste and K101 waste. The primary intent of continuous monitoring was to: 1) observe fluctuations in flue gas parameters, and 2) provide documentation of combustion conditions.

Sample acquisition was accomplished using an in-stack ceramic probe filtered with an out-of-stack Balstron filter. The sample was transported to the mobile laboratory using a heated Teflon^R sample line, maintained at a temperature >120°C. Flue gas analyzed for O_2, CO_2, and CO was first pumped through a sample conditioner to knock out moisture, providing analysis on a dry basis. A separate, unconditioned gas sample was supplied to the THC analyzer for wet basis analysis. The concentrations were continuously recorded on stripcharts.

The following instruments were used to analyze for CO, CO_2, O_2, and THC:

Carbon Monoxide (CO) Concentration	Beckman Model 865 Infrared Analyzer; Range 0-500 ppm
Carbon Dioxide (CO_2) Concentration	Beckman Model 865 Infrared Analyzer; Range 0-20%
Oxygen (O_2) Concentration	Thermox WDG AMETEK; Range 0-25%
Total Hydrocarbon (THC) Concentration	Beckman Model 402 Flame Ionization Detector Range 0-100 ppm

Copies of all continuous emission data were given to the EPA work assignment manager, Mr. Juan Baez-Martinez, prior to leaving the test site.

TABLE 3-1. SUMMARY OF RESULTS OF ARSENIC EMISSIONS SAMPLING

					Arsenic Emissions			
							Arsenic Emissions As AS_2O_3	
			Flow		Total Arsenic			
Sample	% O_2	% H_2O	ACFM	DSCFM	#/hr	kg/hr	#/hr	kg/hr
1	6.1	53.7	1686	630	.0111	.0050	.0147	.0067
2	6.1	56.0	1736	615	.0181	.0082	.0239	.0108
3	5.7	55.5	1695	060	.0231	.0105	.0305	.0139

APPENDIX

RADIAN SOURCE TEST
EPA METHOD 2-5*
(RAW DATA)

PLANT : JOHN ZINK
PLANT SITE : TULSA , OK
SAMPLING LOCATION : SCRUBBER OUTLET
TEST # : BDAT-JZ-1201-AS-01
DATE : 12/01/87
TEST PERIOD : 1725-1830

Reproduced from best available copy.

PARAMETER	VALUE
Sampling time (min.)	60
Barometric Pressure (in.Hg)	29.57
Sampling nozzle diameter (in.)	.376
Meter Volume (cu.ft.)	36.337
Meter Pressure (in.H2O)	1.225
Meter Temperature (F)	74.83335
Stack dimension (sq.in.)	113.0976
Stack Static Pressure (in.H2O)	1.4
Stack Moisture Collected (gm)	378.2
Absolute stack pressure(in Hg)	29.67294
Average stack temperature (F)	189.0833
Percent CO2	8.5
Percent O2	6.1
Percent N2	85.4
Delps Subroutine result	13.12519
DGM Factor	1.0051
Pitot Constant	.84

---

* **Although Method 108 was used for arsenic sampling, EPA Methods 2-5 were used to calculate gas flow and emission rates as shown in the sample calculations to follow.**

```
RADIAN SOURCE TEST
EPA METHODS 2-5
FINAL RESULTS
PLANT                 : JOHN ZINK
PLANT SITE            : TULSA , OK
SAMPLING LOCATION     : SCRUBBER OUTLET
TEST #                : BDAT-JZ-1201-AS-01
DATE                  : 12/01/87
TEST PERIOD           : 1725-1830

PARAMETER                 RESULT
---------                 ------

Vm(dscf)                   35.74246
Vm(dscm)                   1.012226
Vw gas(scf)                41.40713
Vw gas (scm)               1.17265
% moisture                 53.67123
Md                         .4632877
MWd                        29.504
MW                         23.[illegible]599
Vs(fpm)                    2147.268
Vs (mpm)                   654.655
Flow(acfm)                 1686.464
Flow(acmm)                 47.76067
Flow(dscfm)                630.3191
Flow(dscmm)                17.85064
% I                        96.31988
% EA                       37.09199



                                         Program Revision:1/16/84
```

```
          RADIAN  SOURCE  TEST
            EPA  METHOD  5
        PARTICULATE  LOADING
         PLANT                  :  JOHN ZINK
         PLANT SITE             :  TULSA , OK
         SAMPLING LOCATION      :  SCRUBBER OUTLET
         TEST #                 :  BDAT-JZ-1201-AS-01
         DATE                   :  12/01/87
         TEST PERIOD            :  1725-1830

PARAMETER              FRONT-HALF                 TRAIN TOTAL (As)        As2O3
---------              ----------                 -----

Total Grams            0.0041800                  0.0047580
Grams/dscf             0.0001169                  0.0001331
Grams/acf              0.0000437                  0.0000498
Grains/dscf            0.0018045                  0.0020540
Grains/acf             0.0006744                  0.0007677
Grams/dscm             0.0041294                  0.0047004
Grams/acm              0.0015434                  0.0017568
Pounds/dscf            0.0000003                  0.0000003
Pounds/acf             0.0000001                  0.0000001
Pounds/Hr              0.0097524                  0.0111010               .0147
Kilograms/Hr           0.0044237                  0.0050354
                                                                          .0067



                                                  Program Revision:1/16/84
```

```
    RADIAN SOURCE TEST
    EPA METHOD 2-5
     (RAW DATA)
  PLANT                   : JOHN ZINK
  PLANT SITE              : TULSA , OK
  SAMPLING LOCATION       : SCRUBBER OUTLET
  TEST #                  : BDAT-JZ-1201-AS-02
  DATE                    : 12/01/87
  TEST PERIOD             : 1802-1905

PARAMETER                                        VALUE
---------                                        -----

Sampling time (min.)                              60
Barometric Pressure (in.Hg)                       29.57
Sampling nozzle diameter (in.)                    .375
Meter Volume (cu.ft.)                             37
Meter Pressure (in.H2O)                           1.375
Meter Temperature (F)                             81.95833
stack dimension  sq.in.)                          113.0[illegible]6
stack Static Pressure (in.H2O)                    1.4
stack Moisture Collected (gm)                     968.9
Absolute stack pressure(in Hg)                    29.67294
Average stack temperature (F)                     191.25
Percent CO2                                       8.5
Percent O2                                        6.1
Percent N2                                        85.4
Delps Subroutine result                           13.43468
DGM Factor                                        1.0056
Pitot Constant                                    .84
```

```
       RADIAN SOURCE TEST
       EPA METHODS 2-5
       FINAL RESULTS
PLANT                  : JOHN ZINK
PLANT SITE             : TULSA , OK
SAMPLING LOCATION      : SCRUBBER OUTLET
TEST #                 : BDAT-JZ-1201-AS-02
DATE                   : 12/01/87
TEST PERIOD            : 1802-1905

     PARAMETER                    RESULT
     ---------                    ------

     Vm(dscf)                      35.94737
     Vm(dscm)                      1.018029
     Vw gas(scf)                   45.68364
     Vw gas (scm)                  1.293761
     % moisture                    55.96356
     Md                            .4403642
     MWd                           29.804
     MW                            23.10999
     Vs(fpm)                       2210.513
     Vs (mpm)                      673.9369
     Flow(acfm)                    1736.137
     Flow(acmm)                    49.1674
     Flow(dscfm)                   614.7254
     Flow(dscmm)                   17.40902
     % I                           99.85988
     % EA                          37.09199




                                         Program Revision:1/16/84
```

```
      RADIAN SOURCE TEST
        EPA METHOD 5
   PARTICULATE LOADING
    PLANT                  : JOHN ZINK
    PLANT SITE             : TULSA , OK
    SAMPLING LOCATION      : SCRUBBER OUTLET
    TEST #                 : BDAT-JZ-1201-AS-02
    DATE                   : 12/01/87
    TEST PERIOD            : 1802-1905

PARAMETER            FRONT-HALF           TRAIN TOTAL (As)      (As2O3)
---------            ----------           -----

Total Grams          0.0073000            0.0079850
Grams/dscf           0.0002031            0.0002221
Grams/acf            0.0000719            0.0000787
Grains/dscf          0.0031334            0.0034275
Grains/acf           0.0011095            0.0012136
Grams/dscm           0.0071706            0.0078434
Grams/acm            0.0025389            0.0027772
Pounds/dscf          0.0000004            0.0000005
Pounds/acf           0.0000002            0.0000002
Pounds/Hr            0.0165157            0.0180655              .0239
Kilograms/Hr         0.0074915            0.0081944              .0108



                                          Program Revision:1/16/84
   RADIAN  SOURCE  TEST
   EPA  METHOD  2-5
   (RAW  DATA)
 PLANT                 :  JOHN ZINK
 PLANT SITE            :  TULSA , OK
 SAMPLING LOCATION     :  SCRUBBER OUTLET
 TEST #                :  BDAT-JZ-1201-AS-03
 DATE                  :  12/01/87
 TEST PERIOD           :  1920-2024


PARAMETER                                VALUE
---------                                -----

Sampling time (min.)                      60
Barometric Pressure (in.Hg)               29.57
Sampling nozzle diameter (in.)            .376
Meter Volume (cu.ft.)                     35.998
Meter Pressure (in.H20)                   1.220833
Meter Temperature (F)                     71.70833
Stack dimension (sq.in.)                  113.0976
Stack Static Pressure (in.H20)            1.3
Stack Moisture Collected (gm)             942.8
Absolute stack pressure(in Hg)            29.66559
Average stack temperature (F)             190.75
Percent CO2                               10.3
Percent O2                                5.7
Percent N2                                84
Delps Subroutine result                   13.16211
DGM Factor                                1.0051
Pitot Constant                            .84
```

```
     RADIAN  SOURCE  TEST
     EPA  METHODS  2-5
     FINAL  RESULTS
PLANT                 : JOHN ZINK
PLANT SITE            : TULSA , OK
SAMPLING LOCATION     : SCRUBBER OUTLET
TEST #                : BDAT-JZ-1201-AS-03
DATE                  : 12/01/87
TEST PERIOD           : 1920-2024


   PARAMETER                        RESULT
   ---------                        ------

   Vm(dscf)                          35.61675
   Vm(dscm)                          1.008666
   Vw gas(scf)                       44.45302
   Vw gas (scm)                      1.25891
   % moisture                        55.51786
   Md                                .4448215
   MWd                               29.876
   MW                                23.2827
   Vs(fpm)                           2157.885
   Vs (mpm)                          657.8918
   Flow(acfm)                        1694.803
   Flow(acmm)                        47.99681
   Flow(dscfm)                       606.4793
   Flow(dscmm)                       17.17549
   % I                               99.75398
   % EA                              34.59577




                                              Program Revision:1/16/84
```

RADIAN SOURCE TEST
EPA METHOD 5
PARTICULATE LOADING

PLANT : JOHN ZINK
PLANT SITE : TULSA , OK
SAMPLING LOCATION : SCRUBBER OUTLET
TEST # : BDAT-JZ-1201-AS-03
DATE : 12/01/87
TEST PERIOD : 1920-2024

PARAMETER	FRONT-HALF	TRAIN TOTAL (As)	(As_2O_3)
Total Grams	0.0085000	0.0102700	
Grams/dscf	0.0002387	0.0002883	
Grams/acf	0.0000854	0.0001032	
Grains/dscf	0.0036824	0.0044492	
Grains/acf	0.0013177	0.0015921	
Grams/dscm	0.0084268	0.0101816	
Grams/acm	0.0030155	0.0036434	
Pounds/dscf	0.0000005	0.0000006	
Pounds/acf	0.0000002	0.0000002	
Pounds/Hr	0.0191488	0.0231362	.0305
Kilograms/Hr	0.0086858	0.0104945	.0139

Program Revision:1/16/84

RADIAN SOURCE TEST
EPA METHOD 2-5
SAMPLE CALCULATION

PLANT : JOHN ZINK
PLANT SITE : TULSA , OK
SAMPLING LOCATION : SCRUBBER OUTLET
TEST # : BDAT-JZ-1201-AS-03
DATE : 12/01/87
TEST PERIOD : 1920-2024

1) Volume of dry gas sampled at standard conditions (68 deg-F ,29.92 in. Hg).

```
              Y x Vm x [T(std) + 460] x [Pb +(Pm/13.6)]
Vm(std) = ----------------------------------------
                P(std) x (Tm + 460)

             1.0051 x 35.949 x 528 x ( 29.57 + ( [illegible] / 13.6 ) )
Vm(std) = -------------------------------------------
                29.92   x ( 71.70835 + 460)

Vm(std) =   35.617dscf
```

2) Volume of water vapor at standard conditions:

```
Vw(gas) =  0.04715 cf/gm x W(1) gm

Vw(gas) =  0.04715 x  942.8   =  44.453 scf
```

3) Percent Moisture in stack gas :

```
          100 x Vw(gas)
%M = --------------------
      Vm(std)   + Vw(gas)

          100 x  44.453
%M = -------------------- =  55.52 %
      35.617 +   44.453
```

4) Mole fraction of dry stack gas :

```
Md  =    100 -   %M         100 -  55.52
        ------------   =  ------------ =  .4448215
            100               100
```

SAMPLE CALCULATION
PAGE TWO

5) Average Molecular Weight of DRY stack gas :

```
        MWd = (.44 x %CO2) + (.32 x %O2) + (.28 x %N2)

        MWd = (.44 x 10.3 ) + (.32 x 5.7 ) + (.28 x  84 ) =  29.876
```

6) Average Molecular Weight of wet stack gas :

```
        MW   = MWd x Md + 18(1 - Md)

        MW   = 29.876  x  .4448215  + 18(1 -  .4448215 )  =  23.2827
```

7) Stack gas velocity in feet-per-minute (fpm) at stack conditions :

```
Vs = Kp x Cp x [SQRT (dP)](ave) x SQRT [Ts (avg)] x SQRT [1/(Ps x MW)] x 60sec/min

    Vs = 85.49 x .84 x 60 x  13.16211 x SQRT[1/( 29.66559  X  23.2827 )]

    Vs =  2157.885  FPM
```

8) Average stack gas dry volumetric flow rate (DSCFM) :

```
              Vs x As x Md x T(std) x Ps
  Qsd =  ----------------------------------------
         144 cu.in./cu.ft. x (Ts +460) x P(std)

          2157.885 x 113.0976 x .4448215 x528x 29.66559
  Qsd =  ----------------------------------------
          144 x  650.75  x 29.92

  Qsd =  606.4793 dscfm
```

SAMPLE CALCULATION

Isokinetic sampling rate (%):

Dimensional Constant C = K4 x 144 x [1/(pI/4)]
k4 = .0945 For English Units

$$I\% = \frac{C \times Vm(std) \times (Ts + 460)}{Vs \times Tt \times Ps \times Md \times (Dn)\ 2}$$

$$I\% = \frac{1039.574 \times 35.61675 \times 650.75}{2157.885 \times 60 \times 29.66559 \times .4448215 \times (\ .376)\ 2}$$

$I\% = 99.75398$

Excess air (%):

$$EA = \frac{100 \times \%O2}{(.264 \times \%N2) - \%O2} \qquad \frac{100 \times 5.7}{(.264 \times 84) - 5.7}$$

$EA = 34.60$

Particulate concentration:

Cs = (grams As)./Vm(std) = .01027/35.61675

Cs = 0.0002883 Grams/DSCF

$$Ca = \frac{T(std) \times Md \times Ps \times Cs}{P(std) \times Ts}$$

$$Ca = \frac{528 \times .4448215 \times 29.66559 \times}{29.92 \quad \times \quad 650.75} \quad 0.0002883$$

Ca = 0.0001032 Grams/ACF

16 As/hr = Cs x 0.002205 x Qsd x 60

16 As/hr = 0.002883 x 0.002205 x 606.5 x 60

16 As/hr = .0231362

$$16\ As_2O_3 = \frac{16\ As}{hr} \times \frac{16\ mole\ As}{16\ As} \times \frac{16\ mole\ As_2O_3}{2\ 16\ mole\ As} \times \frac{16\ As_2O_3}{16\ mole\ As_2O_3}$$

$$16\ As_2O_3 = \frac{0.0231362 \times 197.84}{74.92 \times 2}$$

$16\ As_2O_3 = 0.0305$

RADIAN SOURCE TEST
EPA METHODS 2-5
DEFINITION OF TERMS

PARAMETER	DEFINITION
Tt(min.)	TOTAL SAMPLING TIME
Dn(in.)	SAMPLING NOZZLE DIAMETER
Ps(in.H2O)	ABSOLUTE STACK STATIC GAS PRESSURE
Vm(cu.ft.)	ABSOLUTE VOLUME OF GAS SAMPLE MEASURED BY DGM
Vw(gm.)	TOTAL STACK MOISTURE COLLECTED
Pm(in.H2O)	AVERAGE STATIC PRESSURE OF DGM
Tm(F)	AVERAGE TEMPERATURE OF DGM
Pb(in.Hg.)	BAROMETRIC PRESSURE
% CO2	CARBON DIOXIDE CONTENT OF STACK GAS
% O2	OXYGEN CONTENT OF STACK GAS
% N2	NITROGEN CONTENT OF STACK GAS
SQR(DELPS)	AVE. SQ. ROOT OF S-PITOT DIFF. PRESSURE-TEMP. PRODUCTS
As(sq.in.)	CROSS-SECTIONAL AREA OF STACK(DUCT)
Ts(F)	TEMPERATURE OF STACK
Vm(dscf)	STANDARD VOLUME OF GAS SAMPLED ,Vm(std),AS DRY STD. CF
Vm(dscm)	STANDARD VOLUME OF GAS SAMPLED,Vm(std),AS DRY STD. CM
Vw gas(scf)	VOLUME OF WATER VAPOR IN GAS SAMPLE,STD
% moisture	WATER VAPOR COMPOSITION OF STACK GAS
Md	PROPORTION, BY VOLUME,OF DRY GAS IN GAS SAMPLE
MWd	MOLECULAR WEIGHT OF STACK GAS,DRY BASIS LB/LB-MOLE
MW	MOLECULAR WEIGHT OF STACK GAS,WET BASIC LB/LB-MOLE
Vs(fpm)	AVERAGE STACK GAS VELOCITY
Flow(acfm)	AVERAGE STACK GAS FLOW RATE(ACTUAL STACK COND.)
Flow(acmm)	AVERAGE STACK GAS FLOW RATE(ACTUAL STACK COND.)
Flow(dscfm)	AVERAGE STACK GAS VOLUMETRIC FLOW RATE(DRY BASIS)
Flow(dscmm)	AVERAGE STACK GAS VOLUMETRIC FLOW RATE(DRY BASIS)
% I	PERCENT ISOKINETIC
% EA	PERCENT EXCESS AIR IN STACK GAS
DGM	DRY GAS METER
Y	DRY GAS METER CORRECTION FACTOR
Pg	STACK STATIC GAS PRESSURE
Cp	PITOT COEFFICIENT
dH	ORIFICE PLATE DIFF. PRESS. VALUE
dP	PITOT DIFF. PRESS. VALUE

*** EPA STANDARD CONDITIONS

Temperature = 68 deg-F (528 deg-R)
Pressure = 29.92 in. Hg.

NATIONAL ANALYTICAL LABORATORIES
A Division of
U.S. POLLUTION CONTROL, INC.

S. SCHWARTZ
VERSAR INC.
P.O. BOX 1549

SPRINGFIELD VA 22151

REPORT NUMBER: L002008

SAMPLE IDENTIFICATION: 2380-01
CUSTOMER IDENTIFICATION: JZ-01 & -02
DATE SAMPLED: 12/01/87
TYPE OF MATERIAL: FILTER/LIQ

DATE RECEIVED: 12/02/87
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	108	2 UG	4180 UG
FINAL WEIGHT OF FILTER	----	0.0001 GRAMS	0.0015 GRAMS

BDL = BELOW DETECTION LIMIT

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VERSAR INC.
P.O. BOX 1549

SPRINGFIELD VA 22151

REPORT NUMBER: L002008

PAGE 2

SAMPLE IDENTIFICATION: 2380-02
CUSTOMER IDENTIFICATION: JZ-03 & -04
DATE SAMPLED: 12/01/87
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	108	2 UG	578 UG

BDL = BELOW DETECTION LIMIT

NATIONAL ANALYTICAL LABORATORIES
A Division of
U.S. POLLUTION CONTROL, INC

S. SCHWARTZ
VERSAR INC.
P.O. BOX 1549

SPRINGFIELD VA 22151

REPORT NUMBER: L002008

SAMPLE IDENTIFICATION: 2380-03
CUSTOMER IDENTIFICATION: JZ-05 & -06
DATE SAMPLED: 12/01/87
TYPE OF MATERIAL: FILTER/LIQ

DATE RECEIVED: 12/02/87
DATE COMPLETED: 12/03/87

ARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	108	2 UG	7300 UG
FINAL WEIGHT OF FILTER	----	0.0001 GRAMS	0.[illegible]54 GRAM

DL = BELOW DETECTION LIMIT

S. SCHWARTZ
VERSAR INC.
P.O. BOX 1549

SPRINGFIELD VA 22151

REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-04
CUSTOMER IDENTIFICATION: JZ-07 & -08
DATE SAMPLED: 12/01/87
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	103	2 UG	685 UG

BDL = BELOW DETECTION LIMIT

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SPRINGFIELD VA 22151

REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-05
CUSTOMER IDENTIFICATION: JZ-09 & -10
DATE SAMPLED: 12/01/87
TYPE OF MATERIAL: FILTER/LIQ

DATE RECEIVED: 12/02/87
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	108	2 UG	8500 UG
FINAL WEIGHT OF FILTER	----	0.0001 GRAMS	0.8243 GRAMS

BDL = BELOW DETECTION LIMIT

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SPRINGFIELD VA 22151

REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-06
CUSTOMER IDENTIFICATION: JZ-11 & -12
DATE SAMPLED: 12/01/87
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	108	2 UG	1770 UG

BDL = BELOW DETECTION LIMIT

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SPRINGFIELD VA 22151

EPORT NUMBER: L002008 PAGE 7

AMPLE IDENTIFICATION: 2380-07 DATE RECEIVED: 12/02/87
USTOMER IDENTIFICATION: JZ-13 H2O BLANK DATE COMPLETED: 12/03/87
ATE SAMPLED: 12/01/87
YPE OF MATERIAL: LIQUID

ARAMETER	REF. METHOD	DET. LIMIT	RESULT
RSENIC (T)	100	2 UG	BDL UG

DL = BELOW DETECTION LIMIT

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SPRINGFIELD VA 22151

REPORT NUMBER: L002008

PAGE 8

SAMPLE IDENTIFICATION: 2380-08
CUSTOMER IDENTIFICATION: JZ-14 NAOH BLANK
DATE SAMPLED: 12/01/87
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	108	2 UG	BDL UG

BDL = BELOW DETECTION LIMIT

Date (DDMMYY): 11/30/87

Initials of Calibrator: JBC

Nozzle Identification No.	D_1 (inches)	D_2 (inches)	D_3 (inches)	Average Diameter (inches)
A-1	.187 D_4 .185	.186 D_5 .187	.186 D_6 .188	.187
A-2	.252 D_4 .251	.251 D_5 .253	.253 D_6 .255	.253 [illegible]
A-3	.304 D_4 .313	.312 D_5 .312	.312 D_6 .313	.312
A-4	.376 .377	.374 .376	.375 .376	.376

Note: The maximum acceptable difference between any two measurements is 0.004 inches. If this tolerance cannot be met, the nozzle should not be used.

Date (DDMMYY): 11/30/87

Initials of Calibrator: BC

Nozzle Identification No.	D_1 (inches)	D_2 (inches)	D_3 (inches)	Average Diameter (inches)
B-1	.186 D_4 .187	.185 D_5 .188	.187 D_6 .186	.187
B-2	.252 .254	.252 ~~.247~~ .252	.251 .252	.252
B-3	.302 .302	.301 .302	.303 .303	.302
B-4	.373 .374	.375 .375	.374 .375	.375

Note: The maximum acceptable difference between any two measurements is 0.004 inches. If this tolerance cannot be met, the nozzle should not be used.

Nozzle calibration sheet.

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RADIAN
CORPORATION

PLANT John Zink
DATE 12-4-81
SAMPLING LOCATION Outlet
SAMPLE TYPE AS
RUN NUMBER JSDATT-JZ-1201-AS-01
OPERATOR DE
AMBIENT [redacted] 1.0
BAROME 28.37
STATIC P , (P_s) +1.4
FILTER NO

PROBE LENGTH AND TYPE 2' glass ~~.374~~
NOZZLE I.D. .374
ASSUMED MOISTURE, % 56
SAMPLE BOX NUMBER
METER BOX NUMBER 1
METER ΔH@ 1.83
C FACTOR 4.7
PROBE HEATER SETTING 248325
HEATER BOX SETTING 248325
REFERENCE Δp
METER γ 1.0051

K=4.7

1830

SCHEMATIC OF TRAVERSE POINT LAYOUT

Times are EST Should be 1725

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F			
		1825	75.267									
A-1	5	1830	78.17	.25	1.2	1.2	178	74	68	3	268	54
2	10	1835	81.04	.24	1.1	1.1	188	77	68	5	264	53
3	15	1840	84.20	.28	1.3	1.3	186	81	68	7	261	
4	20	1845	87.47	.28	1.3	1.3	187	84	69	7	267	52
5	25	1850	90.57	.28	1.3	1.3	188	86	69	7	270	
6	30	1855	93.805	.30	1.4	1.4	190	86	69	7	272	50
		1900	93.805									
B-1	5	1905	96.48	.22	1.0	1.0	190	80	69	3	275	62
2	10	1910	99.47	.25	1.2	1.2	192	82	68	5	269	52
3	15	1915	102.48	.27	1.2	1.2	193	82	67	5	270	45
4	20	1920	105.49	.27	1.2	1.2	193	83	67	5	269	46
5	25	1925	108.54	.29	1.3	1.3	192	83	67	6	264	47
6	30	1930	111.604	.27	1.2	1.2	192	82	67	5	263	48
			Leak ✓ after = 0.008 @ 10" Hg									
			[illegible]			1.225	159	[illegible]				

COMMENTS

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EPA (Dur) 235
1.7

Source Sampling Field Data

ORGANIC SAMPLING TRAIN RECOVERY SHEET

PLANT John Zink
DATE 11/30/87
SAMPLING LOCATION Scrubber Out.
SAMPLE TYPE Arsenic
RUN NUMBER BDAT-JZ-1201-As-02
SAMPLE BOX NUMBER
CLEAN-UP PERSON Doerle
SOLVENT USED 0.1N NaOH

COMMENTS:

FRONT HALF - PARTICULATE PHASE

			GRAVIMETRIC RESULTS	LABORATORY RESULTS
SOLVENT WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER		CONTAINER #	FINAL: mg TARE: mg NET: mg	mg
F/2 Rinse [illegible]	231.7 ml	CONTAINER #	FINAL: mg TARE: mg NET: mg	mg
		FRONT HALF SUBTOTAL	mg	mg

ORGANIC-VAPOR PHASE

TRANSFER LINE AND CONDENSER (SOLVENT RINSE)		~~CONTAINER #~~ JZ-04	mg
RESIN TRAP (XAD-2) (NOTE): CAP & LABEL IMMEDIATELY	B/2 Filter holder	~~TRAP #~~ 27.5 ml NaOH	mg
IMPINGER NO. 1 (QA)		CONTAINER #	NET GAIN (See Impinger Results Reverse Side) mg
			TOTAL mg

NaOH Rinse

50.6 + 16.5
[illegible]6.1 + 33.1
[illegible]2.0 + 23.4
[illegible].9 + 26.8

NOTES/OBSERVATIONS

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)
1*	Empty	0	K.O.	Final 752.0 Initial [illegible] Wt. gain [illegible]
2	H2O	~120 ml	modified	Final 912.4 Initial [illegible] Wt. gain [illegible]
3	H2O	~110 ml	G.S.	Final 928.9 Initial [illegible] Wt. gain 310.9
4	empty	0	modified	Final 550.6 Initial [illegible] Wt. gain [illegible]
5	Silica Gel	~250g	modified	Final 740.0 Initial [illegible] Wt. gain [illegible]
6				Final Initial Wt. gain
7				Final Initial Wt. gain

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 968.90

*QA SAMPLE FOR ORGANIC COLLECTION EFFICIENCY - SAVE IN CONTAINER #.

Samples for Further Analysis:

Sample No.	Description	Species	Results (Total mg.)

RADIAN

181

PLANT John Zinc
DATE 12-1-87
SAMPLING LOCATION outlet
SAMPLE TYPE As
RUN NUMBER [illegible]-52-1201-As-02
OPERATOR Doerle
AMBIENT [redacted] 60
BAROME 29.57
STATIC +14
FILTER

PROBE LENGTH AND TYPE 2' glass
NOZZLE I.D. .375 [illegible]
ASSUMED MOISTURE, % 5%
SAMPLE BOX NUMBER
METER BOX NUMBER 7
METER ΔH@ 1.96
C FACTOR 5
PROBE HEATER SETTING 248±25
HEATER BOX SETTING 248±25
REFERENCE Δp
METER Y 1.0056

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
		1802	81.000									
A-6	5	1807	84.00	.29	1.4	1.4	193	77	74	6	250	50
5	10	1812	87.09	.27	1.4	1.4	194	79	75	6	254	52
4	15	1817	91.34	.28	1.4	1.4	194	80	74	8	269	47
3	20	1822	93.29	.27	1.3	1.3	194	88	74	6	274	45
2		1827	96.75	.32	1.4	1.4	193	90	74	7	275	47
1	30	1832	99.706	.27	1.3	1.3	193	94	75	7	268	48
		1835	99.706									
B-1	5	1840	102.90	.30	1.5	1.5	192	88	76	6	273	64
2	10	1845	106.09	.30	1.5	1.5	193	92	77	6	261	56
3	15	1850	109.09	.26	1.3	1.3	185	93	77	4	266	53
4	20	1855	112.10	.24	1.3	1.3	185	93	77	4	256	48
5	25	1860	115.116	.26	1.3	1.3	186	92	76	4	255	48
6	30	[illegible]	118.000	.25	1.3	1.3	193	92	75	4	256	48
		c1905										
			LEAK V = 0.004@10"									
			37.00				191	82				

COMMENTS

EPA [illegible]

Source Sampling Field Data

ORGANIC SAMPLING TRAIN RECOVERY SHEET

PLANT John Zink

DATE 11/30/87

SAMPLING LOCATION Scrubber Out.

SAMPLE TYPE Arsenic

RUN NUMBER ~~[illegible]~~ BWAT-JZ-1201-As-01

SAMPLE BOX NUMBER

CLEAN-UP PERSON D. Deerie

SOLVENT USED D.I. NaOH

COMMENTS:

FRONT HALF - PARTICULATE PHASE

			GRAVIMETRIC RESULTS	LABORATORY RESULTS
SOLVENT WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER #	FINAL:	mg	
		TARE:	mg	
		NET:	mg	mg
~~FILTER NUMBER~~ F½ NaOH = 227.1 ml	CONTAINER #	FINAL	mg	
		TARE	mg	
Filter(g)		NET:	mg	mg
		FRONT HALF SUBTOTAL	mg	mg

~~**ORGANIC-VAPOR PHASE**~~

~~TRANSFER LINE AND CONDENSER (SOLVENT RINSE)~~	CONTAINER # JZ-04		mg
~~RESIN TRAP (XAD-2) (NOTE: CAP & LABEL IMMEDIATELY)~~ Filter holder B½ rinse	29.3 ml		mg
~~IMPINGER NO. 1 (QA)~~	CONTAINER #A	NET GAIN (See Impinger Results Reverse Side)	mg
		TOTAL	mg

NOTES/OBSERVATIONS.

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)
1*	Empty	0	K.O.	Final 635.6 Initial ~~[illegible]~~ 462.6 Wt. gain [illegible]
2	H_2O	~100 ml	modified	Final 905.5 Initial [illegible] Wt. gain 305.5
3	H_2O	~110 ml	G.S.	Final 850.3 Initial [illegible] Wt. gain 227.1
4	empty	0	modified	Final 546.9 Initial [illegible] Wt. gain 22.5
5	Silica gel	250g	modified	Final 731.7 Initial 700.8 Wt. gain 30.9
6				Final Initial Wt. gain
7				Final Initial Wt. gain

Rinses
mL NaOH
= 2nd
[illegible] ½ F
[illegible] in bottle 4
.6 + 27.4
.4 + 29.4
+ 22.5
.4 + 31.4
All in bottle 3

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 878.20

*QA SAMPLE FOR ORGANIC COLLECTION EFFICIENCY - SAVE IN CONTAINER #A.

Samples for Further Analysis:

Sample No.	Description	Species	Results (Total mg.)

DRY MOLECULAR WEIGHT DETERMINATION

PLANT [illegible]
DATE 1 Dec 87
SAMPLING TIME (24-hr CLOCK)
SAMPLING LOCATION OUTLET
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) INTEGRATED
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE
OPERATOR JBC

COMMENTS: Taken during 1st M108 (As) Run

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	84	84	85	8.5			85	44/100	
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	145	61	145	6.0			6.1	32/100	
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)								28/100	
								TOTAL	29.60

EPA (Dur) 230
4/72

RADIAN
CORPORATION

PLANT John Zink
DATE 12-01-87
SAMPLING LOCATION Scrubber Out
SAMPLE TYPE AS
RUN NUMBER BWT-JZ-1201-AS-03
OPERATOR Doerle
AMBIENT TEMPERATURE 40
BAROMETRIC PRESSURE 29.57
STATIC PRESSURE, (P_s) -1.3
FILTER NUMBER (s) NA

PROBE LENGTH AND TYPE 2' glass
NOZZLE I.D. .376 OD
ASSUMED MOISTURE, % 5%
SAMPLE BOX NUMBER
METER BOX NUMBER
METER ΔH@ 1.83
C FACTOR 4.2
PROBE HEATER SETTING 248 ± 25
HEATER BOX SETTING 248 ± 25
REFERENCE Δp
METER Y 1.0054

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
		1922	12.000									
A-1	5	1925	15.05	.26	1.2	1.2	188	74	64	2	274	45
2	10	1930	17.76	.23	1.05	1.05	190	78	64	2	275	46
3	15	1935	20.66	.25	1.1	1.1	191	80	64	3	272	50
4	20	1940	23.65	.27	1.2	1.2	192	80	64	3	269	60
5	25	1945	26.95	.28	1.3	1.3	191	81	65	4	270	50
6	30	1950	27.940	.27	1.2	1.2	190	81	65	3	274	52
		1954	29.940									
B-1	35	1959	33.04	.32	1.5	1.5	188	76	65	4	274	52
2	40	2004	36.01	.26	1.2	1.2	192	80	64	3	265	45
3	45	2009	38.97	.26	1.2	1.2	191	80	64	4	270	44
4	50	2014	42.07	.28	1.3	1.3	192	80	64	4	271	42
5	55	2019	45.15	.28	1.3	1.3	193	80	64	4	267	41
6	60	2024	47.998	.24	1.1	1.1	191	80	64	4	267	41
			LEAK V after = 0.002 (a) 8"									
			35.998			1.2	191	71.7				

COMMENTS

EPA (Dur) 235
4-77

Source Sampling Field Data

ORGANIC SAMPLING TRAIN RECOVERY SHEET

PLANT John Zink
DATE 12/01/87
SAMPLING LOCATION Scrubber Out
SAMPLE TYPE Arsenic
RUN NUMBER BDAT-JZ-1201-As-03
SAMPLE BOX NUMBER __________
CLEAN-UP PERSON Dowdy
SOLVENT CODES 0.1N NaOH

COMMENTS:

FRONT HALF - PARTICULATE PHASE

			GRAVIMETRIC RESULTS	LABORATORY RESULTS
SOLVENT WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER # ____	FINAL:	____ mg	
		TARE:	____ mg	
		NET:	____ mg	____ mg
FILTER NUMBERS ____ ____	CONTAINER # ____	FINAL:	____ mg	
____ ____		TARE:	____ mg	
____ ____		NET:	____ mg	____ mg
		FRONT HALF SUBTOTAL	____ mg	____ mg

ORGANIC-VAPOR PHASE

TRANSFER LINE AND CONDENSER (SOLVENT RINSE)	CONTAINER # JZ 12		____ mg
RESIN TRAP (XAD-2) (NOTE): CAP & LABEL IMMEDIATELY	B/2 F.H. = 26 ml NaOH		____ mg
IMPINGER NO. 1 (QA)	CONTAINER #4 ____	NET GAIN ____ (See Impinger Results Reverse Side)	____ mg
		TOTAL	____ mg

NOTES/OBSERVATIONS.

	Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)	
27.0 + 16.4	1*	empty	-0-	modified	Final	914.4
					Initial	470.5
					Wt. gain	444.9
9.7 + 30.6	2	H2O	~130 ml	modified	Final	898.7
					Initial	601.9
					Wt. gain	296.80
3.5 + 34.8	3	H2O	~100 ml	~~modified~~ G-S	Final	739.7
					Initial	582.5
					Wt. gain	157.20
27.8 + 26.1	4	empty	-0-	modified	Final	483.4
					Initial	455.1
					Wt. gain	28.30
	5	Silica Gel	~250g	modified	Final	691.4
					Initial	675.8
					Wt. gain	15.60
	6				Final	
					Initial	
					Wt. gain	
	7				Final	
					Initial	
					Wt. gain	

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 942.80

*QA SAMPLE FOR ORGANIC COLLECTION EFFICIENCY - SAVE IN CONTAINER #4.

Samples for Further Analysis:

Sample No.	Description	Species	Results (Total mg.)

DRY MOLECULAR WEIGHT DETERMINATION

PLANT JOHN ZINC

DATE 1 DEC 87

SAMPLING TIME (24-hr CLOCK)

SAMPLING LOCATION OUTLET

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) INTEGRATED

ANALYTICAL METHOD ORSAT

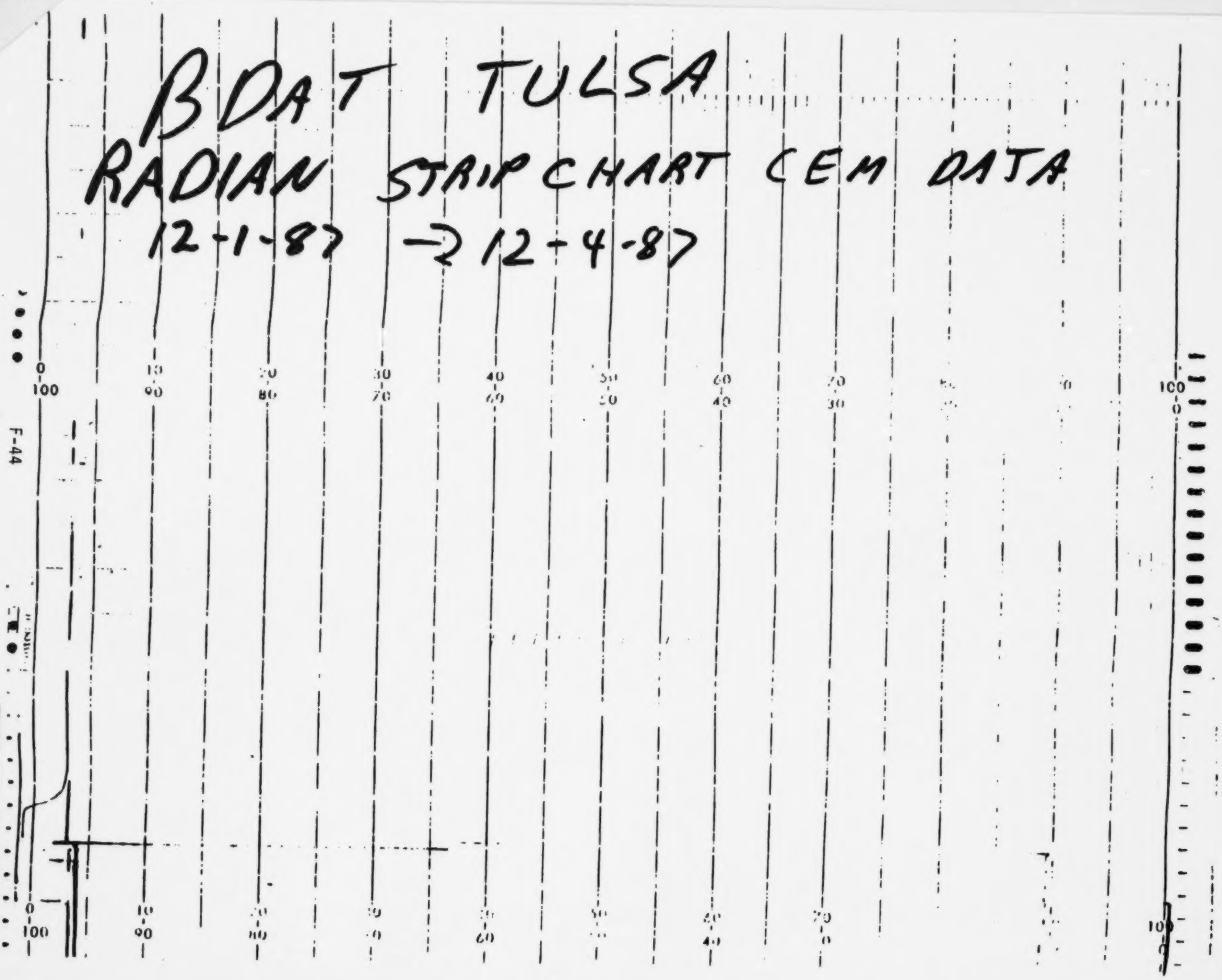
AMBIENT TEMPERATURE

OPERATOR JSC

COMMENTS: Taken during 3rd M108 (As) Run.

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	10.4	10.4	10.2	10.2			10.3	44/100	
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	16.0	5.6	16.0	5.8			5.7	32/100	
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)								28/100	
								TOTAL	29.88

EPA (Dur) 230
4/72



BDAT TULSA
RADIAN STRIPCHART CEM DATA
12-1-87 → 12-4-87

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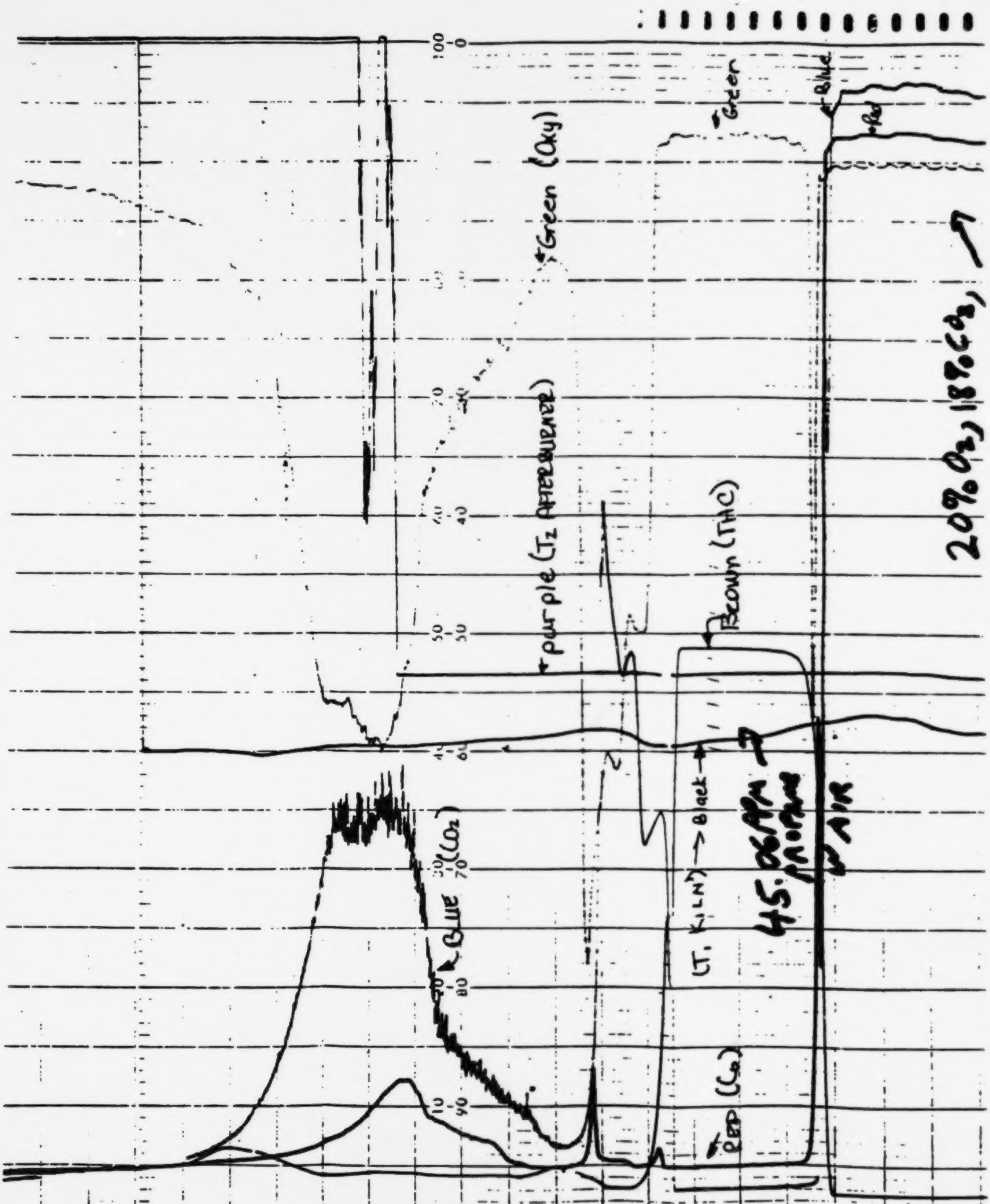
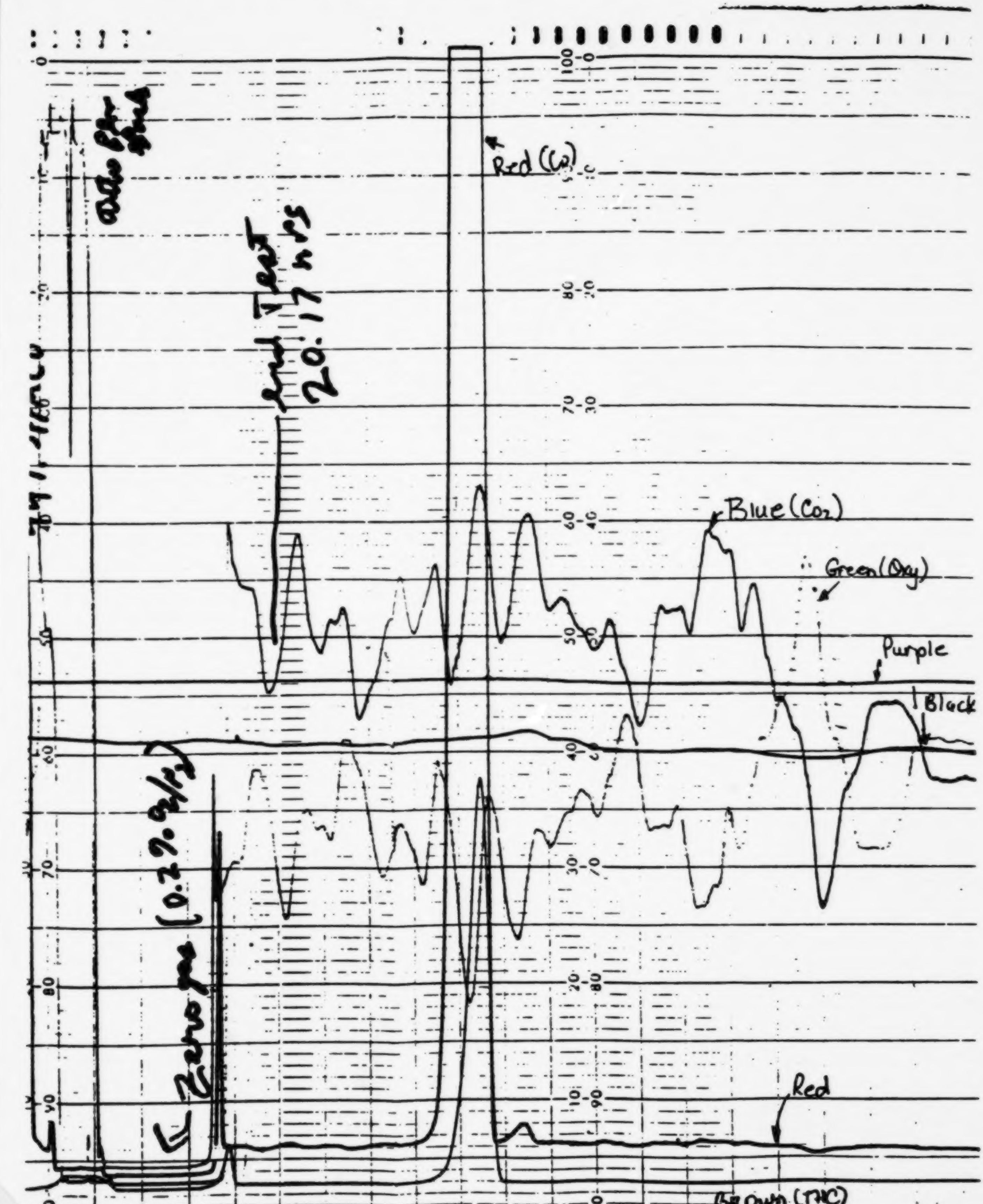
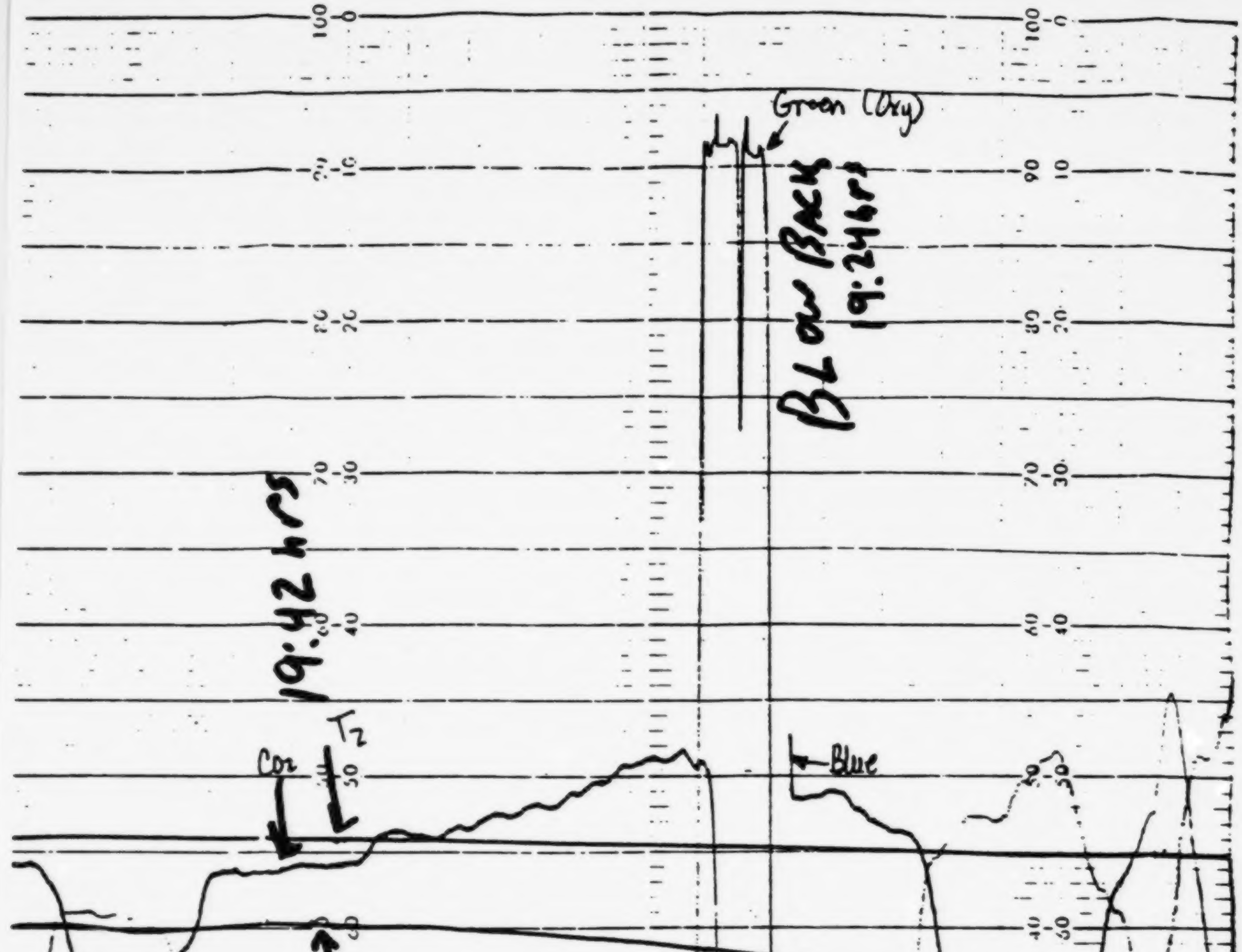
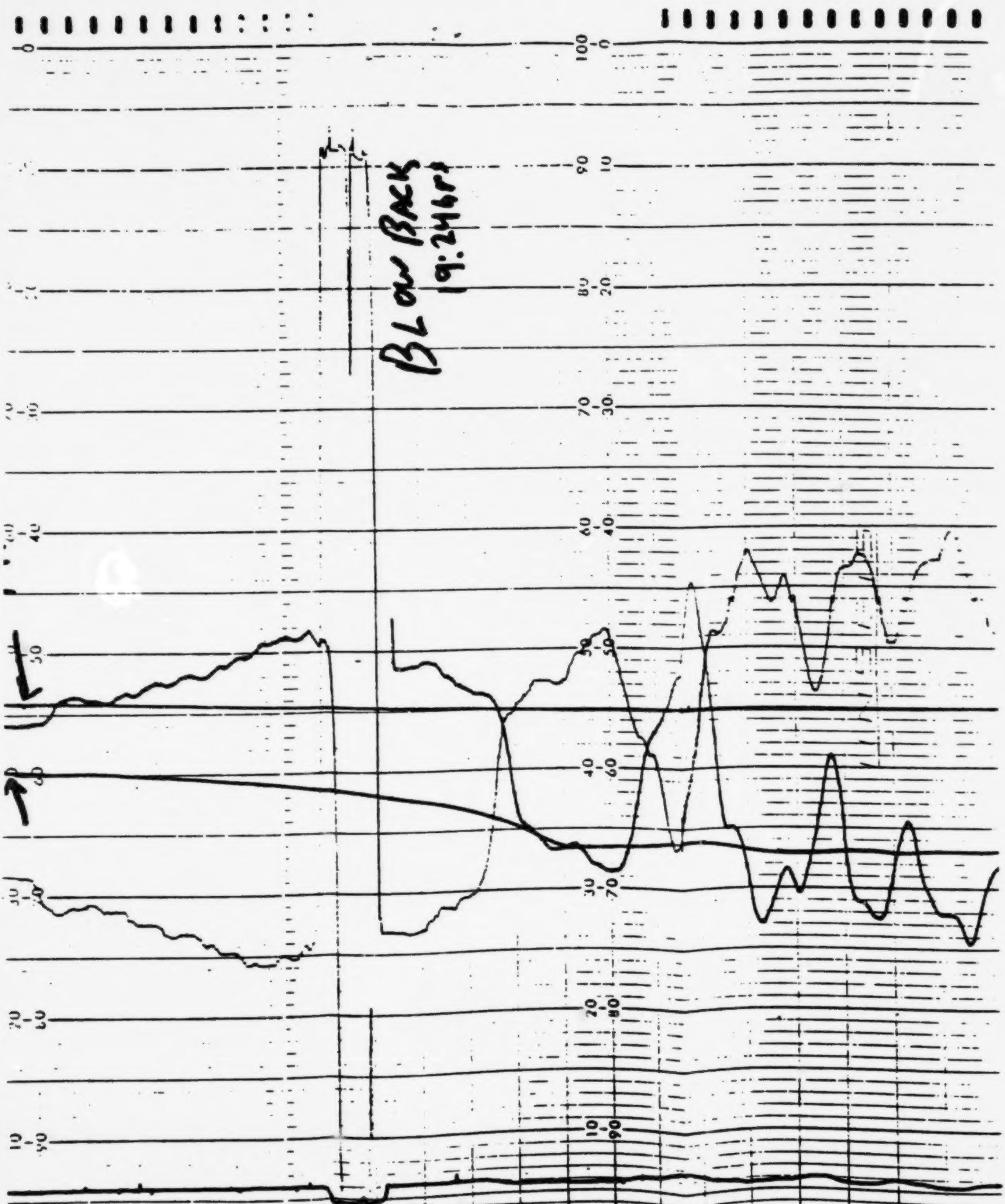
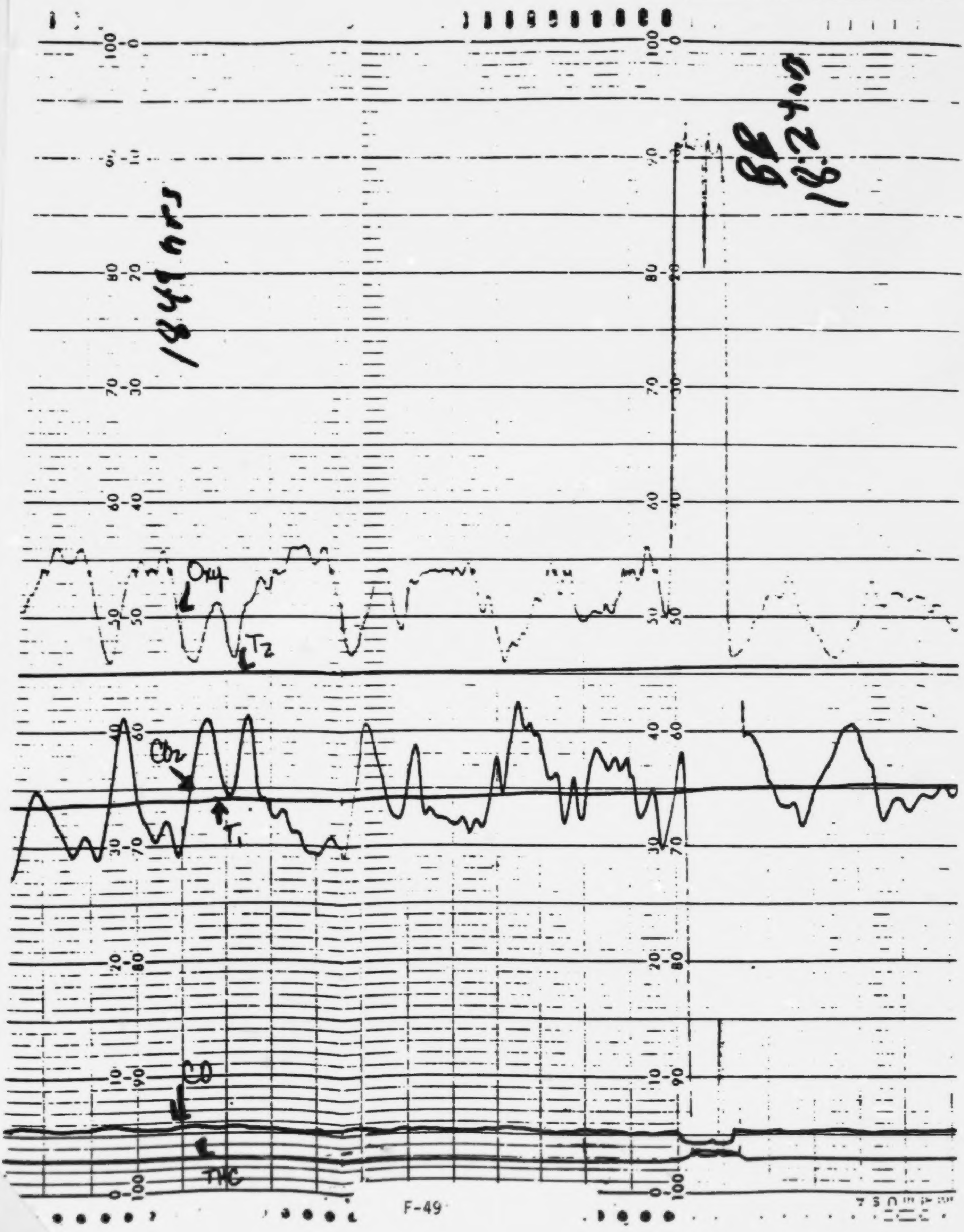
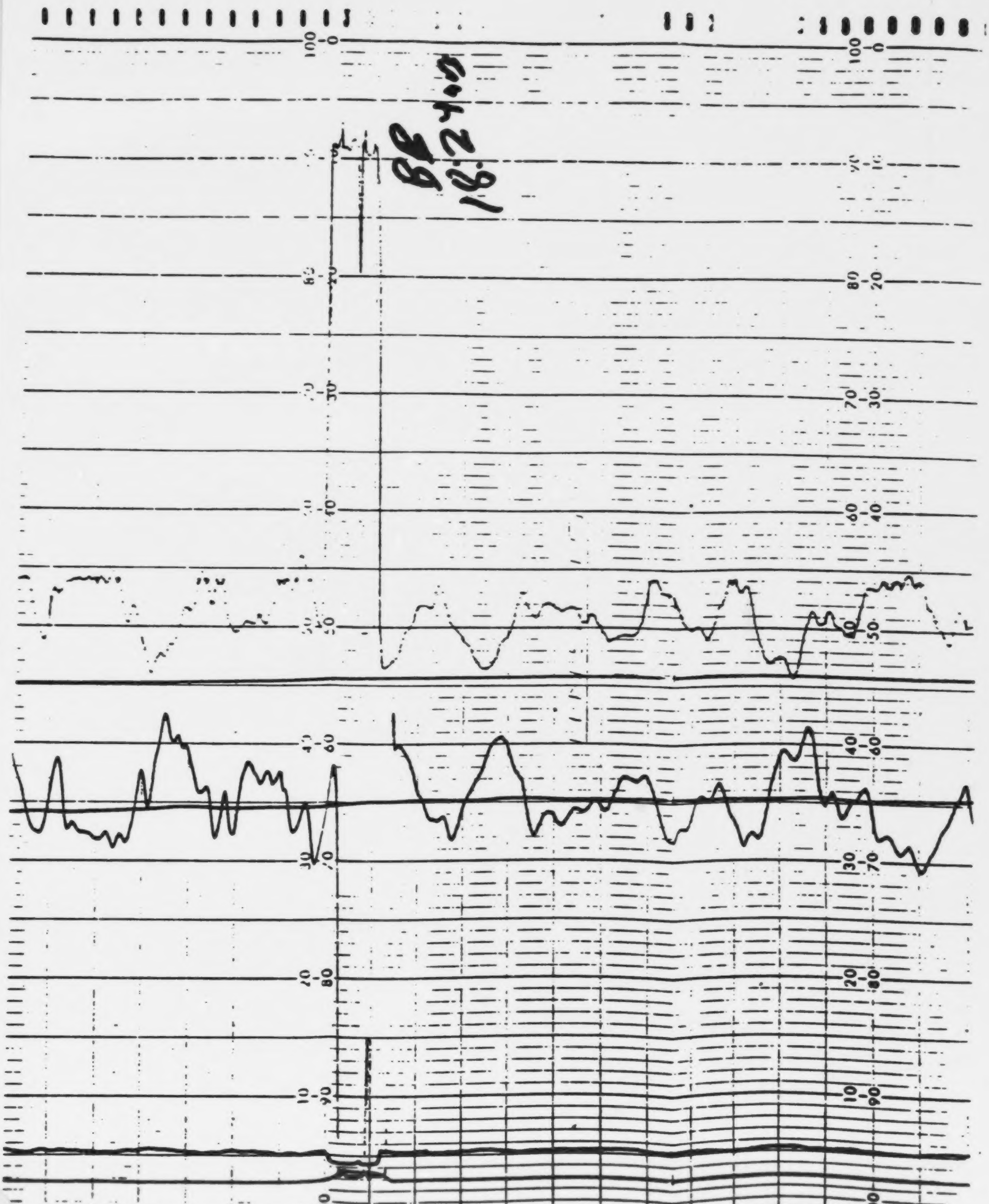

Green (Oxy)
Green
Blue
Red
purple (T2 AFTERBURNER)
Brown (THC)
(T, KILN) → Black
BLUE (CO2)
RED (CO)
45.06 PPM PROPANE
AIR
20% O2, 18% CO2
100 0
10 90
20 80
30 70
40 60
50 50
Printed in U.S.A.


End Test 20:17 hrs
Zero gas (0.29% O2/N2)
Red (Co)
Blue (Co2)
Green (Oxy)
Purple
Black
Red
Brown (THC)
0
10
20
30
40
50
60
70
80
90
100

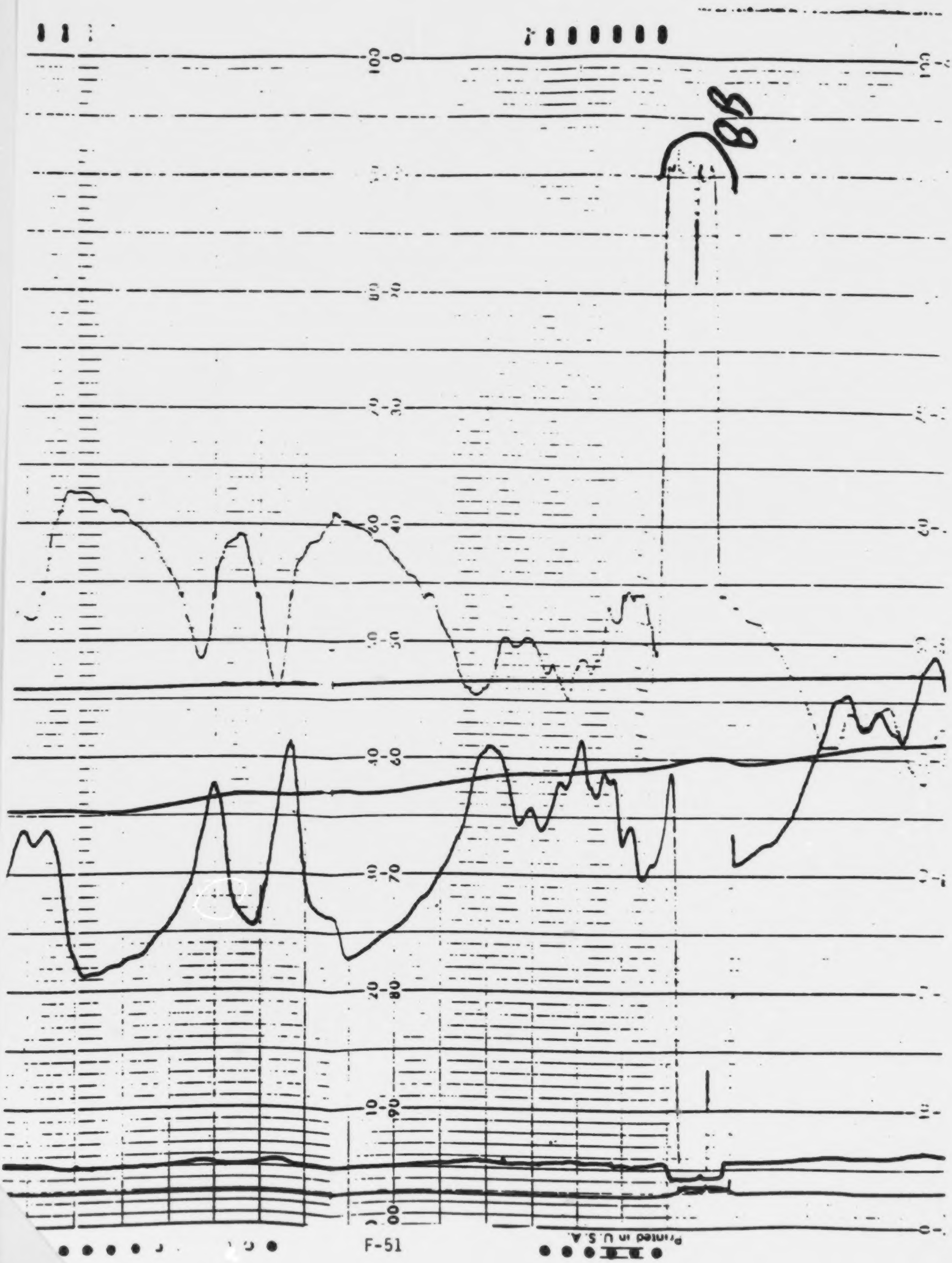

Green (Oxy)
BLOW BACK
19:24hrs
19:42 hrs
CO2
T2
Blue
T1
Oxy
Green
CO
& THC
100 0
90 10
80 20
70 30
60 40
50 50
40 60
30 70
20 80
10 90
0 100


BLOW BACK
19:24hrs
100
90
80
70
60
50
40
30
20
10
0
Printed in U.S.A.


1844 hrs
18:24 hrs
BB
O2
T2
CO2
T1
CO
THC
100
0
90
10
80
20
70
30
60
40
50


100 0
90 10
80 20
70 30
60 40
50 50
40 60
30 70
20 80
10 90
0 100
88
16:24:05

F-50



F-51

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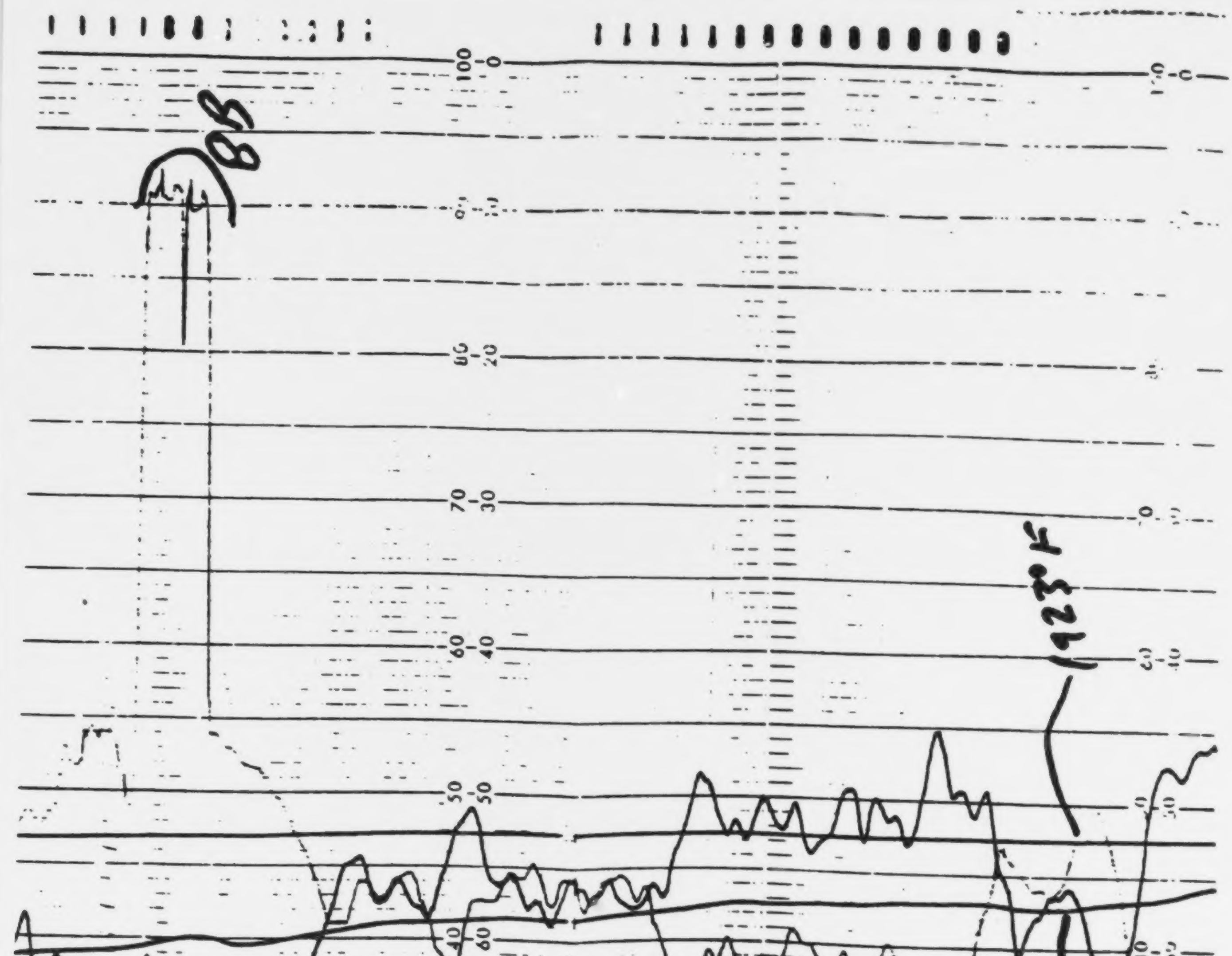
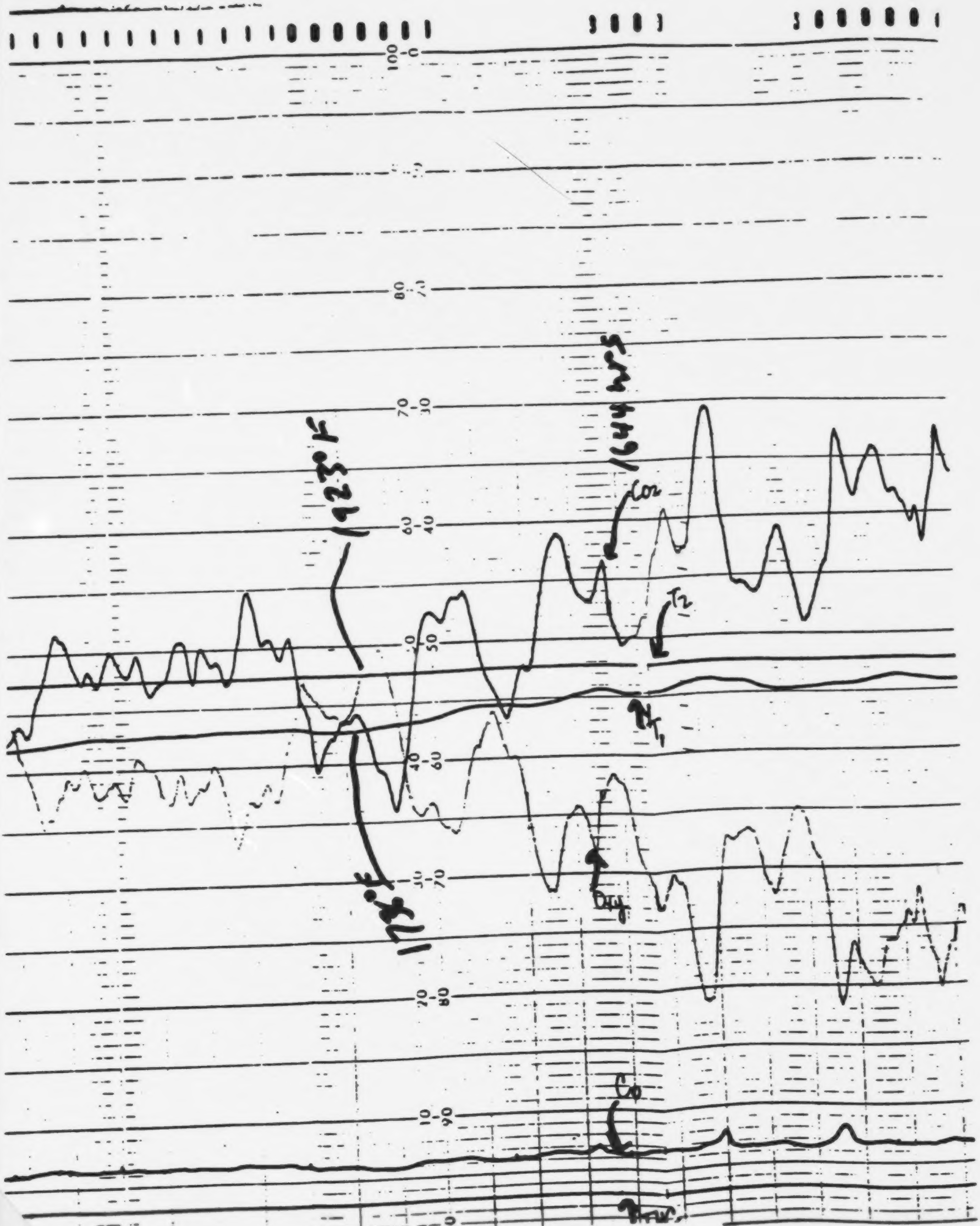
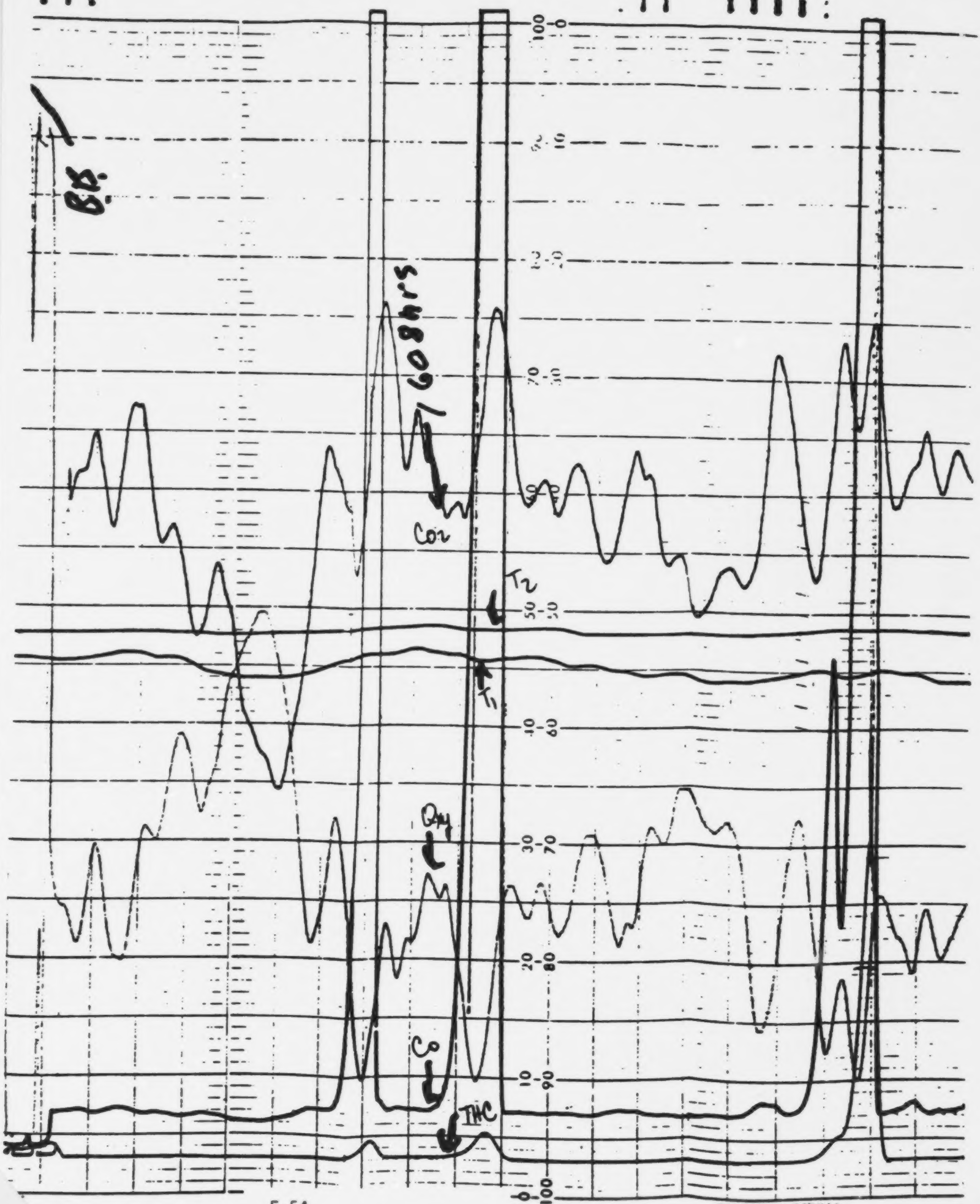
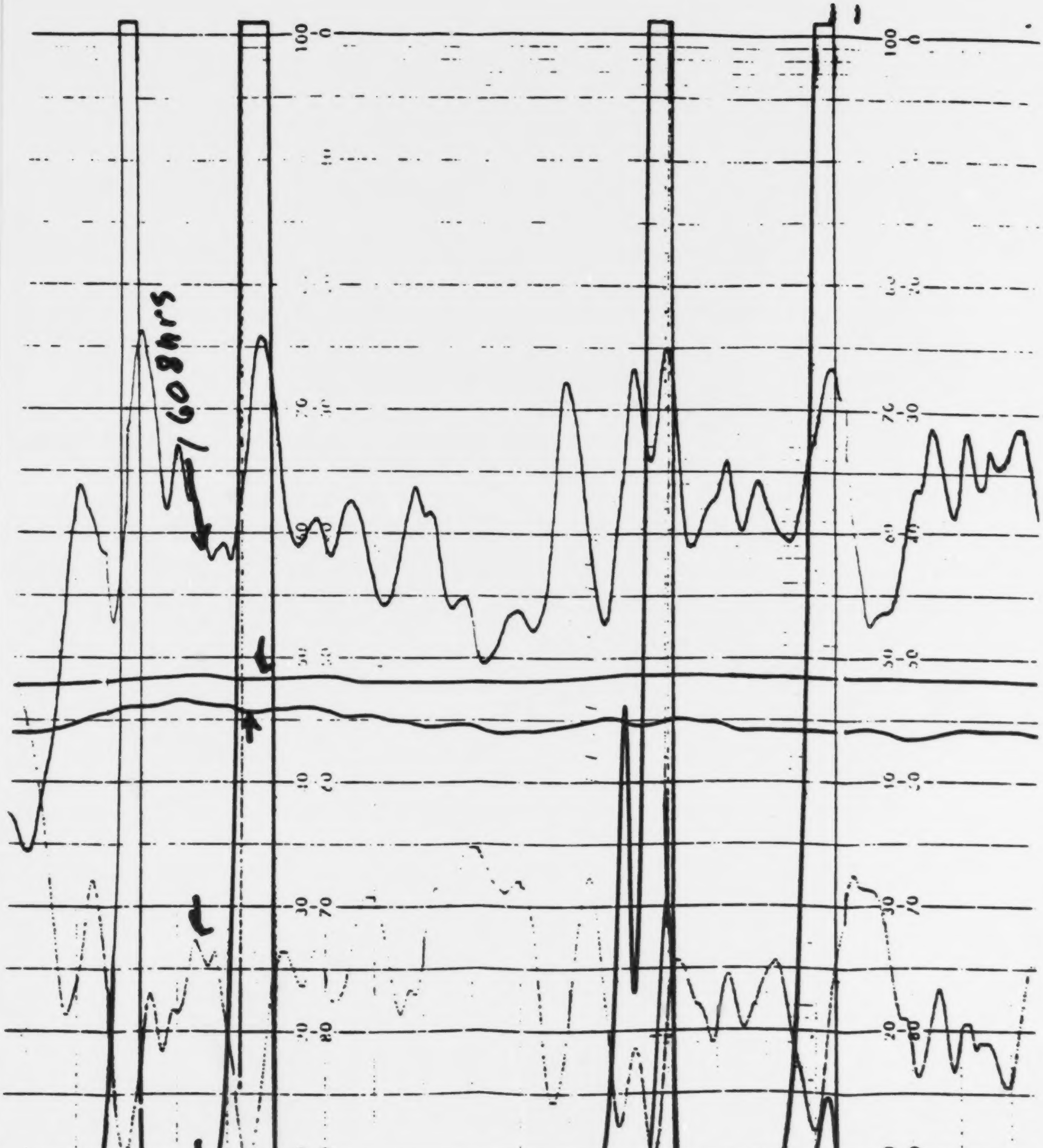
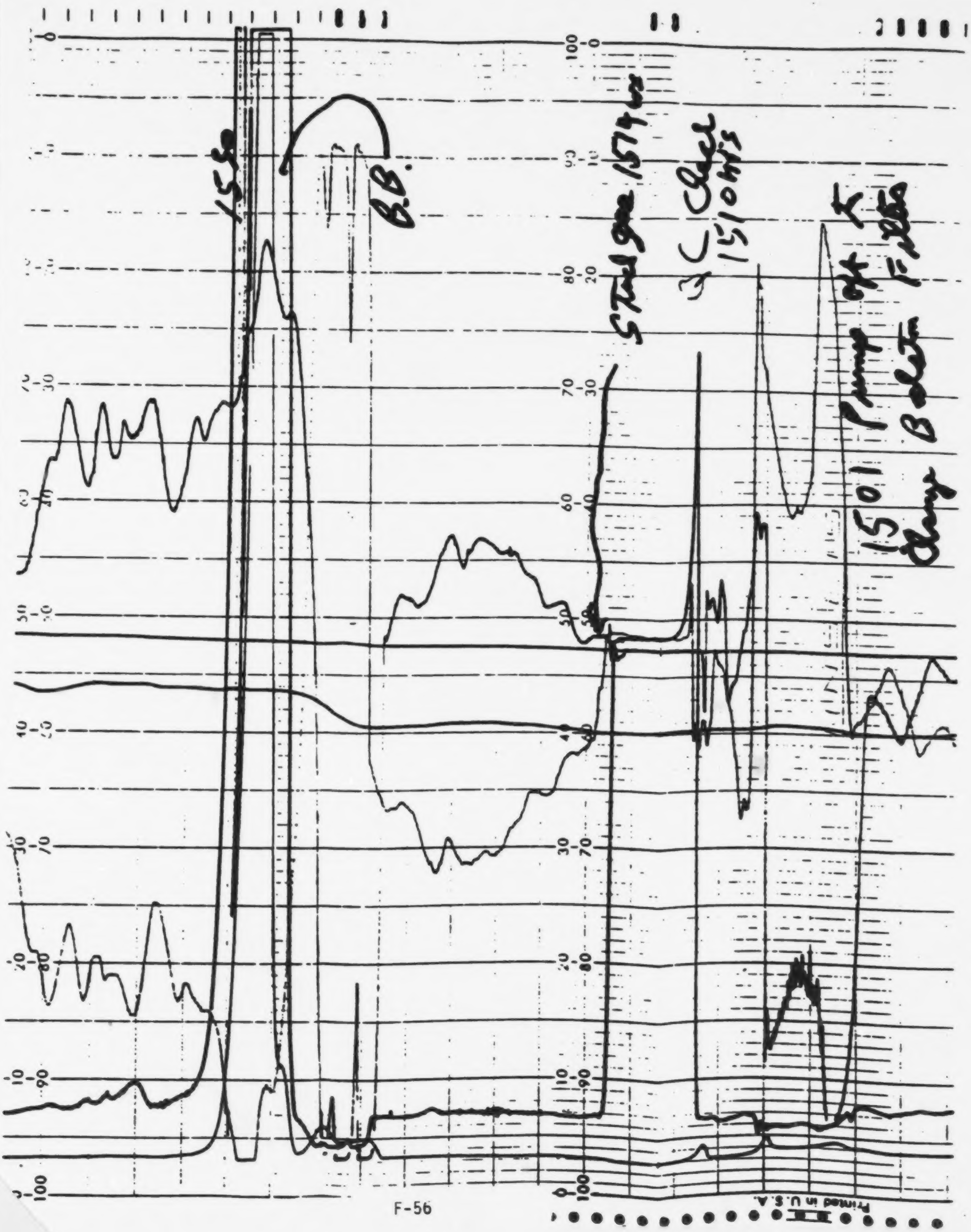

88
1423.5
178.3
100-0
90-10
80-20
70-30
60-40
50-50
40-60
30-70
20-80
10-90
0-100

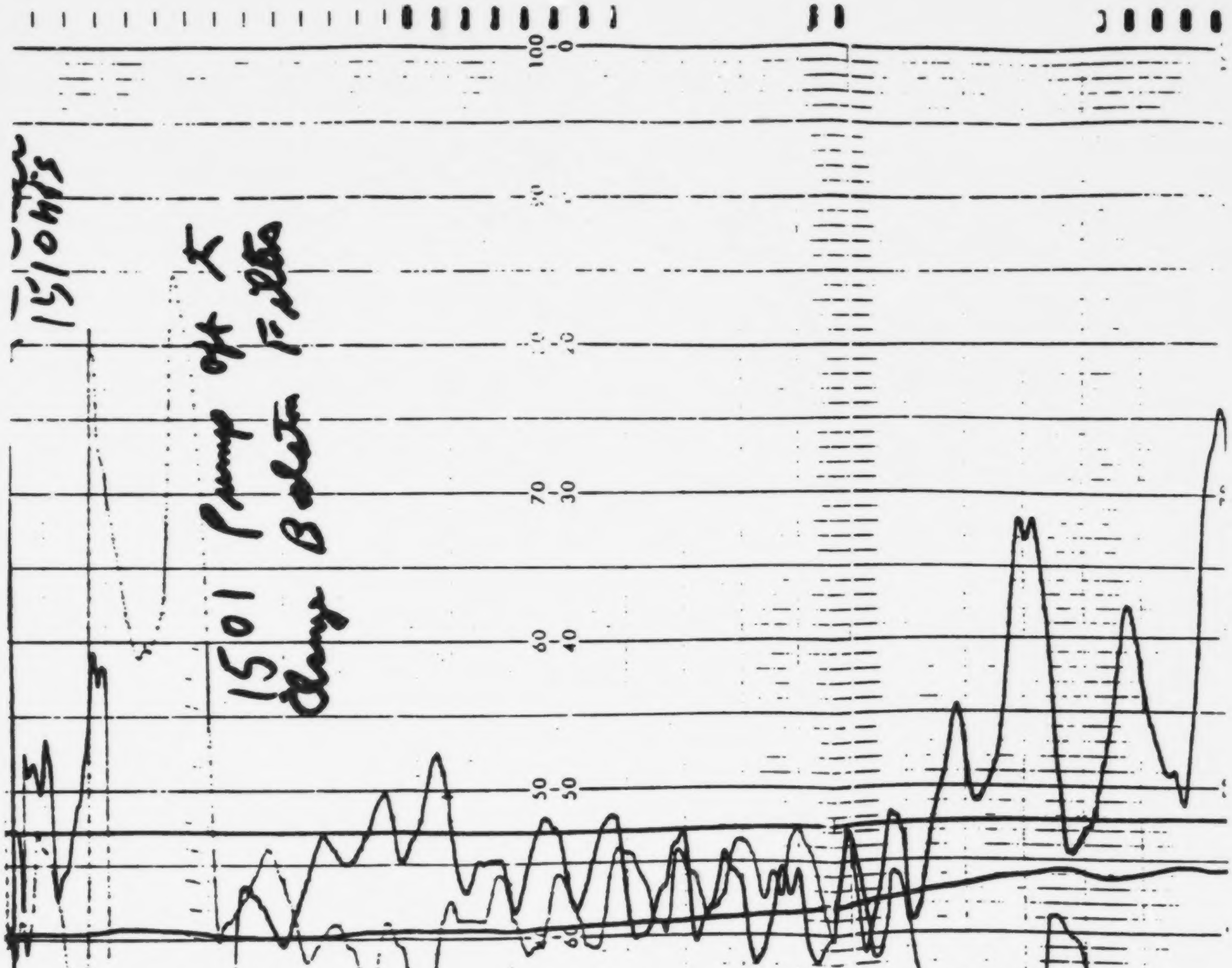

1923°F
1644 hrs
CO2
T2
TH1
O2
178°F
CO
Prin
100
0
80
70
30
60
40
50
0
40
60
30
70
20
80
10
90
0
100


B.D.
1608hrs
CO2
T2
T1
O2
CO
THC
100 0
90 10
80 20
70 30
60 40
50 50
40 60
30 70
20 80
10 90
0 100
Printed in U.S.A.

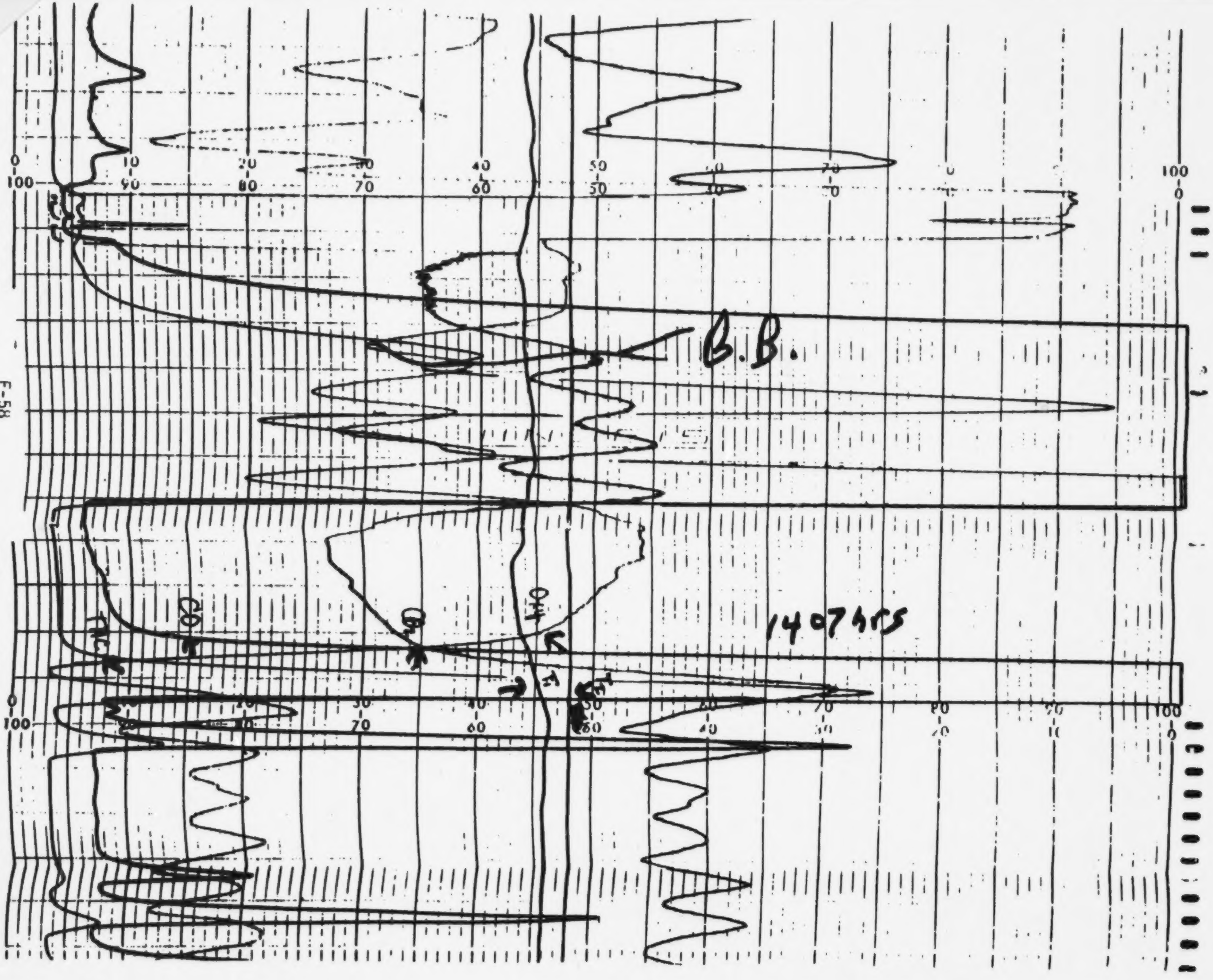

100-0
70-30
60-40
50-50
40-60
30-70
20-80
10-90
0-100
100-0
70-30
60-40
50-50
40-60
30-70
20-80
10-90
0-100

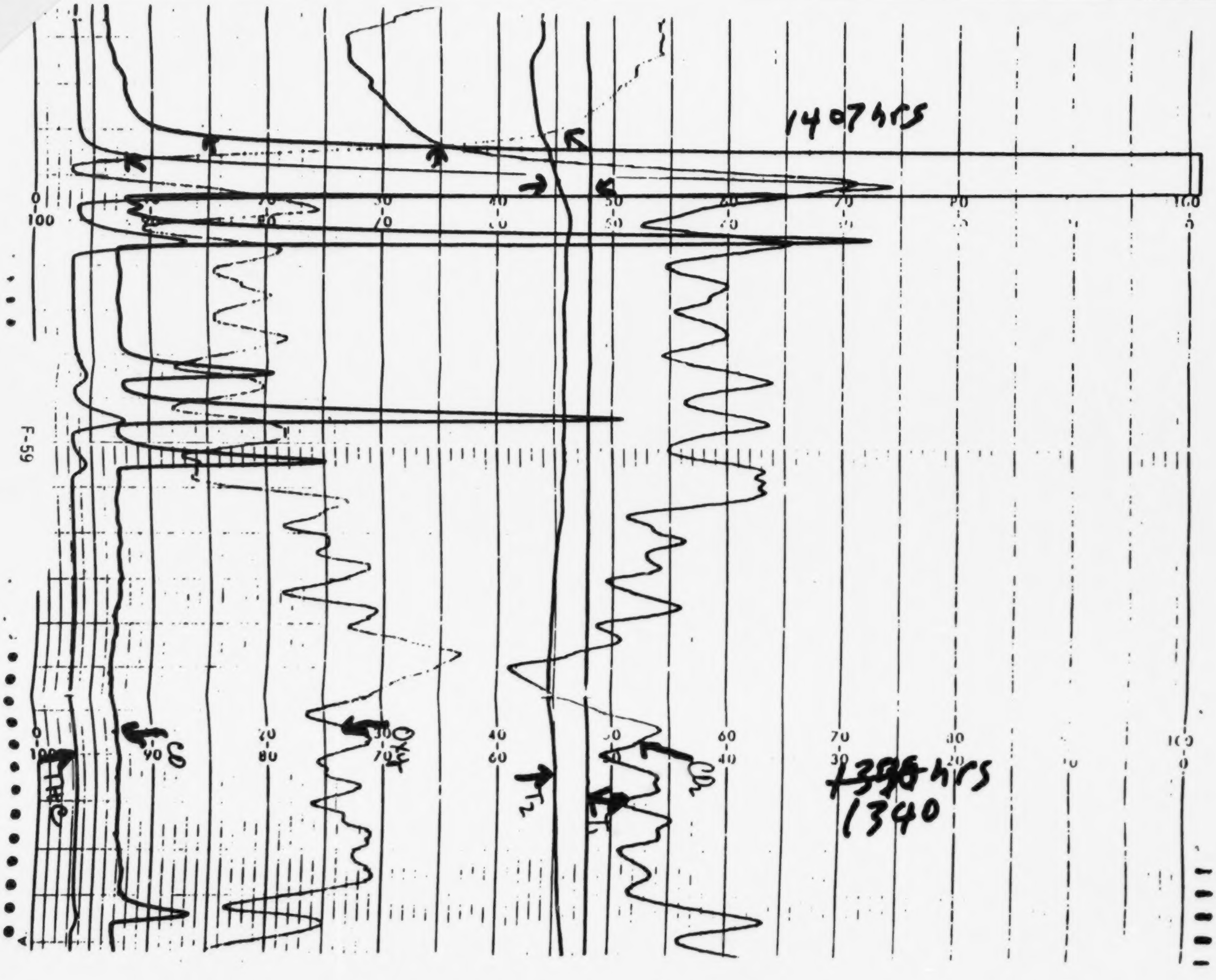
1608hrs

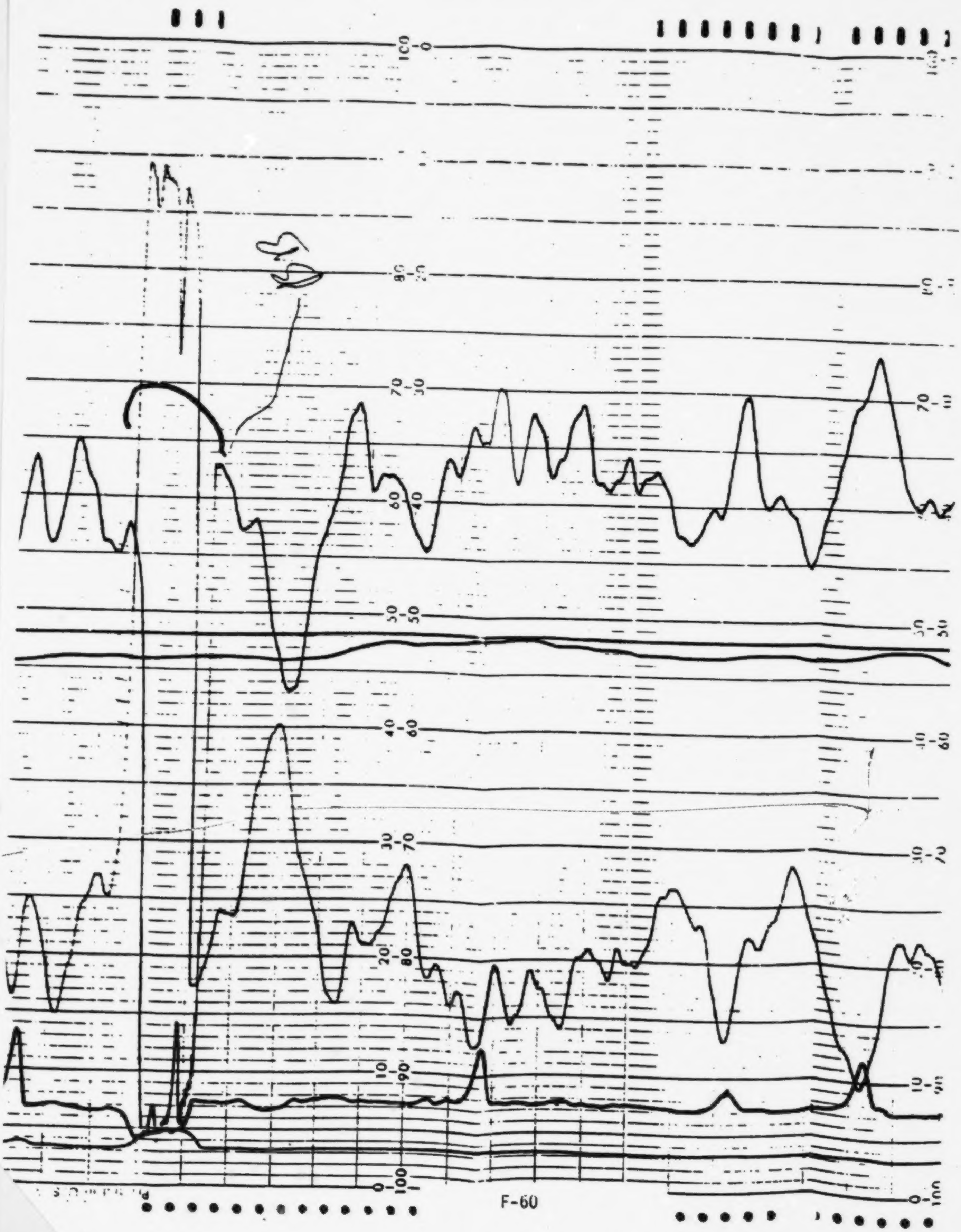

1530
B.B.
STud gone 1514 hrs
℄ Clock 1510 HRS
1501 Pump off to
Change Ballast Filter
Printed in U.S.A.


1510 HRS
1501 Pump off & Change Bolston Filter
100-0
90
20
70-30
60-40
50-50
60
30-70
20-80
10-90
00

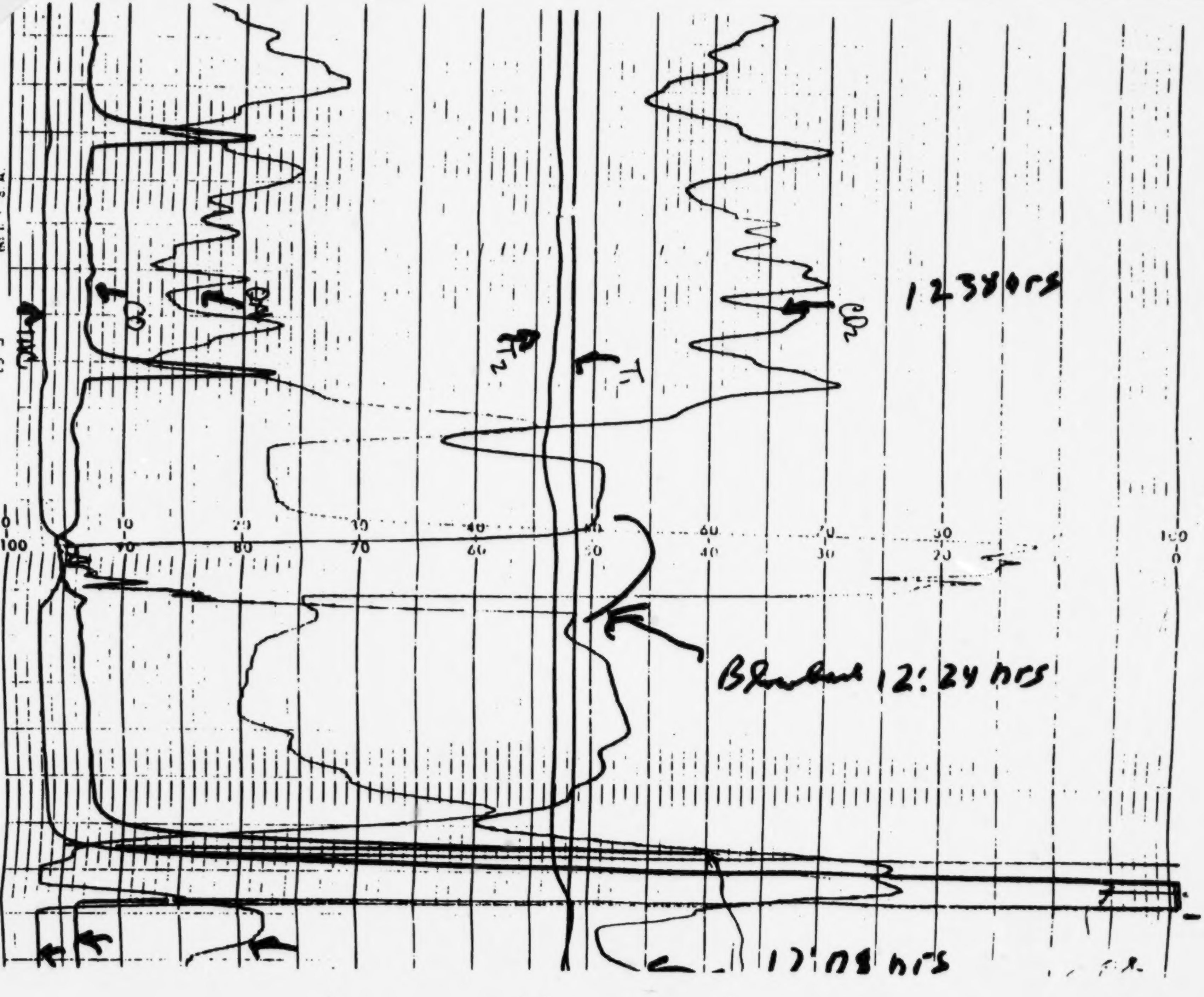
F-57

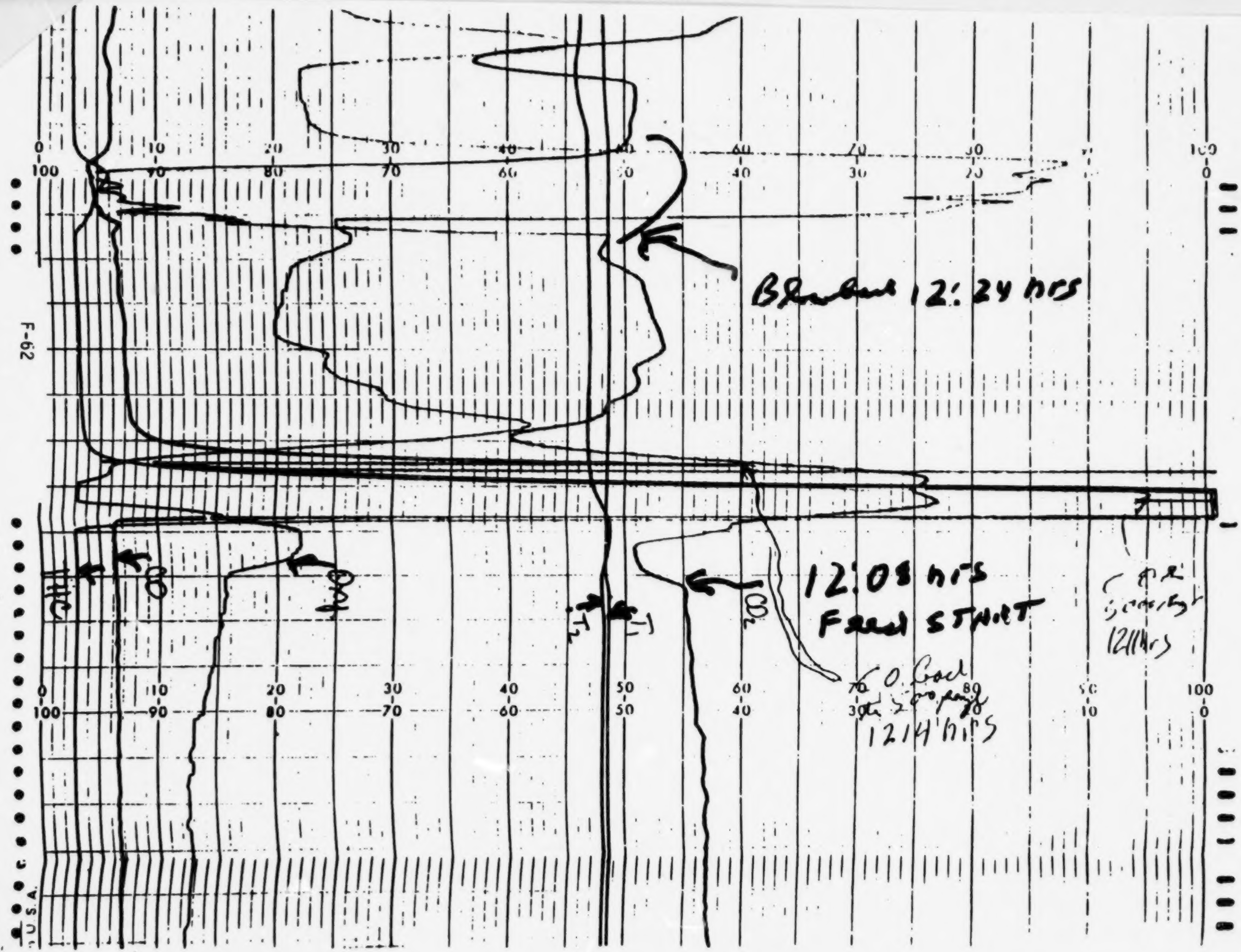

B.B.
1407 hrs
O2
T
CO2
CO
THC
0
10
20
30
40
50
60
70
80
90
100

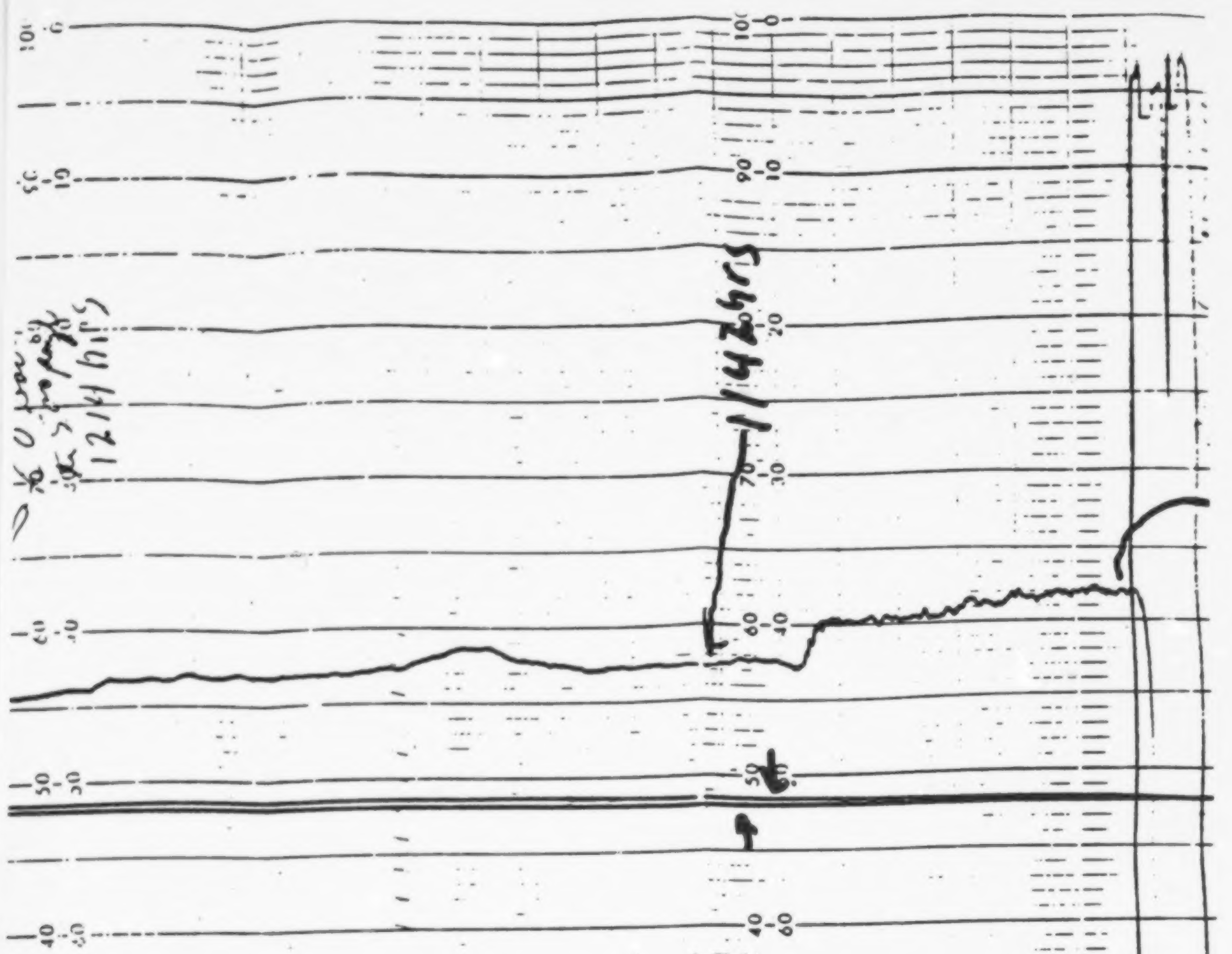

1407 hrs
~~1396~~ hrs
1340
CO₂
T₁
T₂
Oxy
CO
THC
0
10
20
30
40
50
60
70
80
90
100

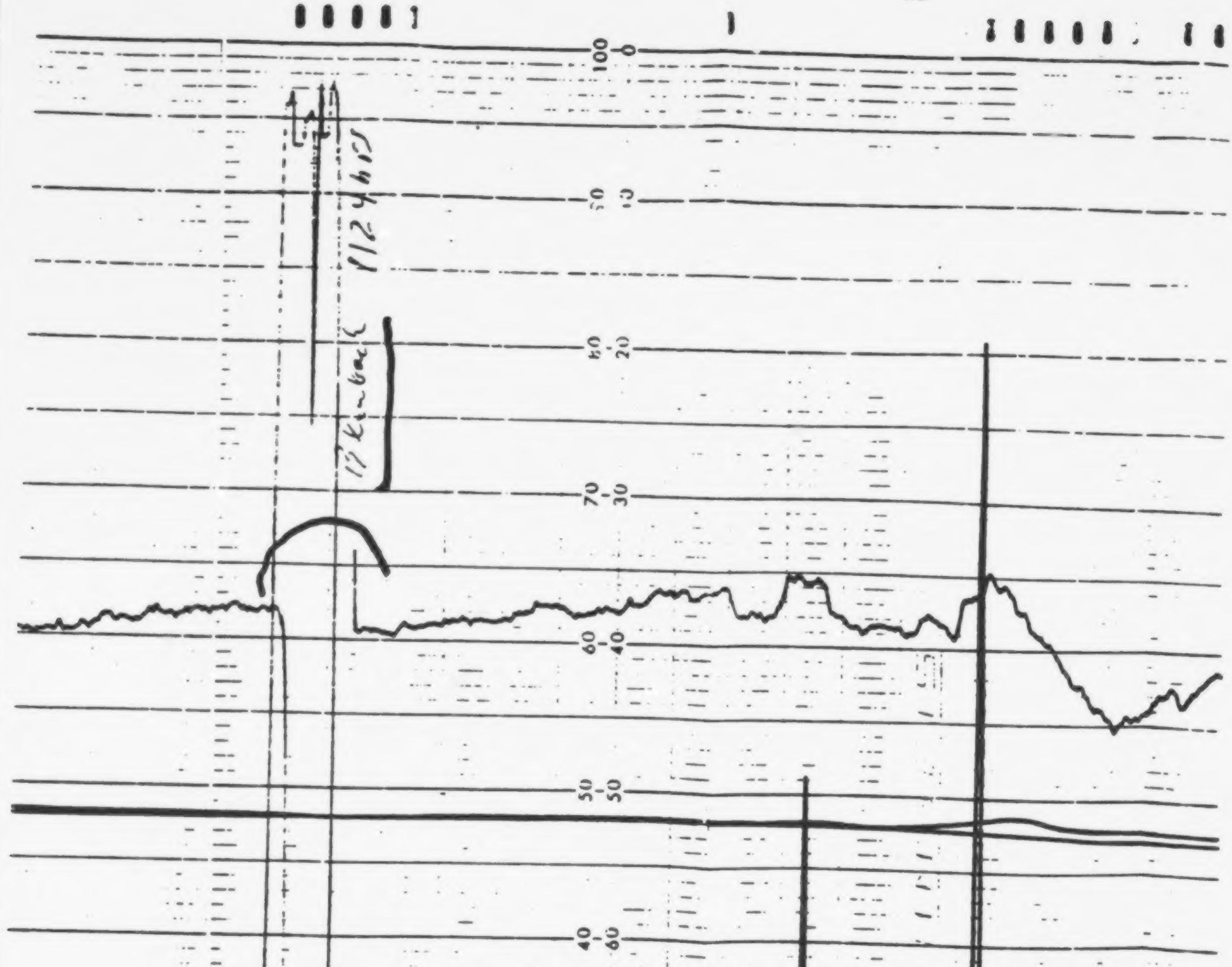


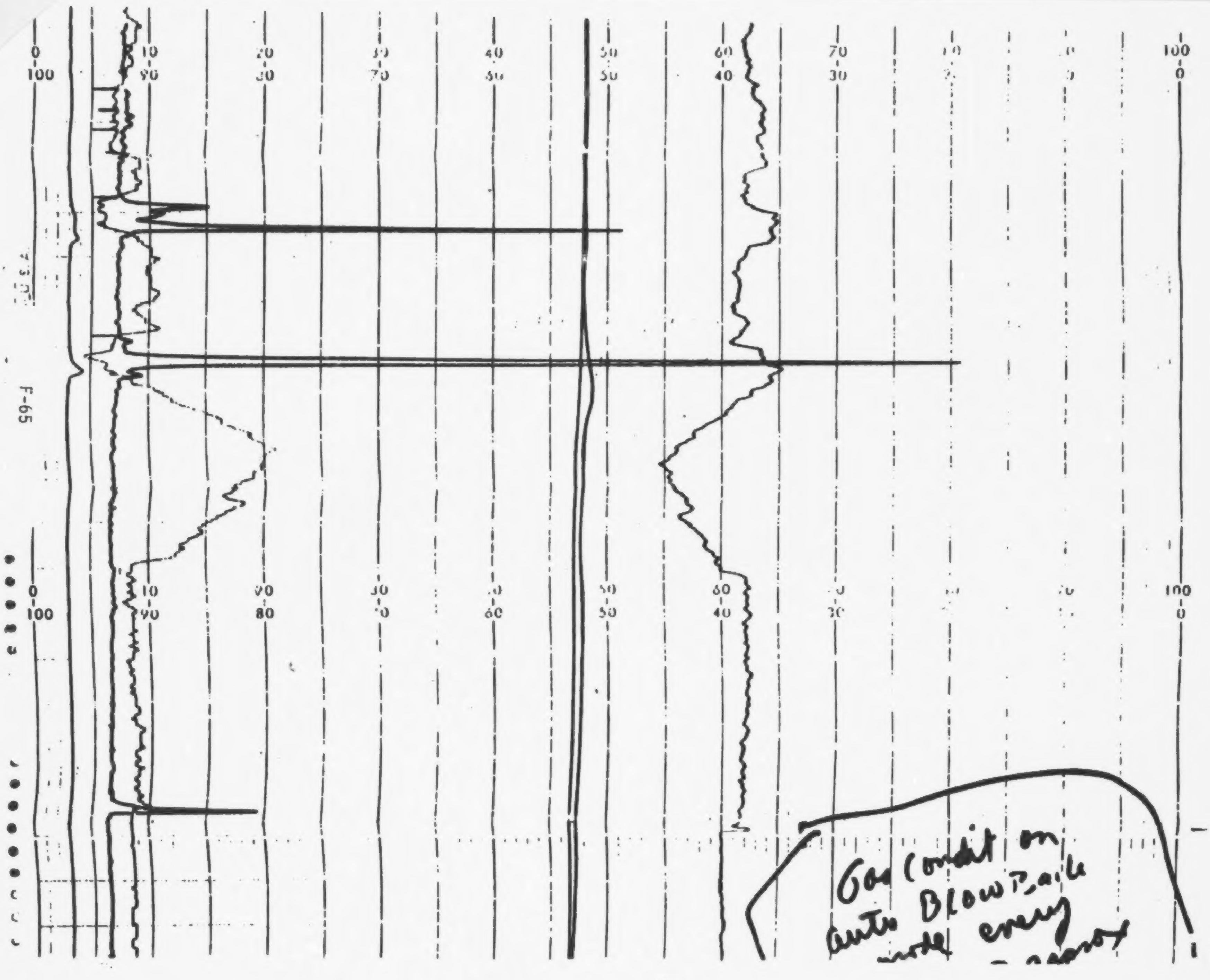
F-60


12:38 hrs
Blank 12:24 hrs
12:08 hrs
CO2
T1
T2
O2
CO
THC
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0

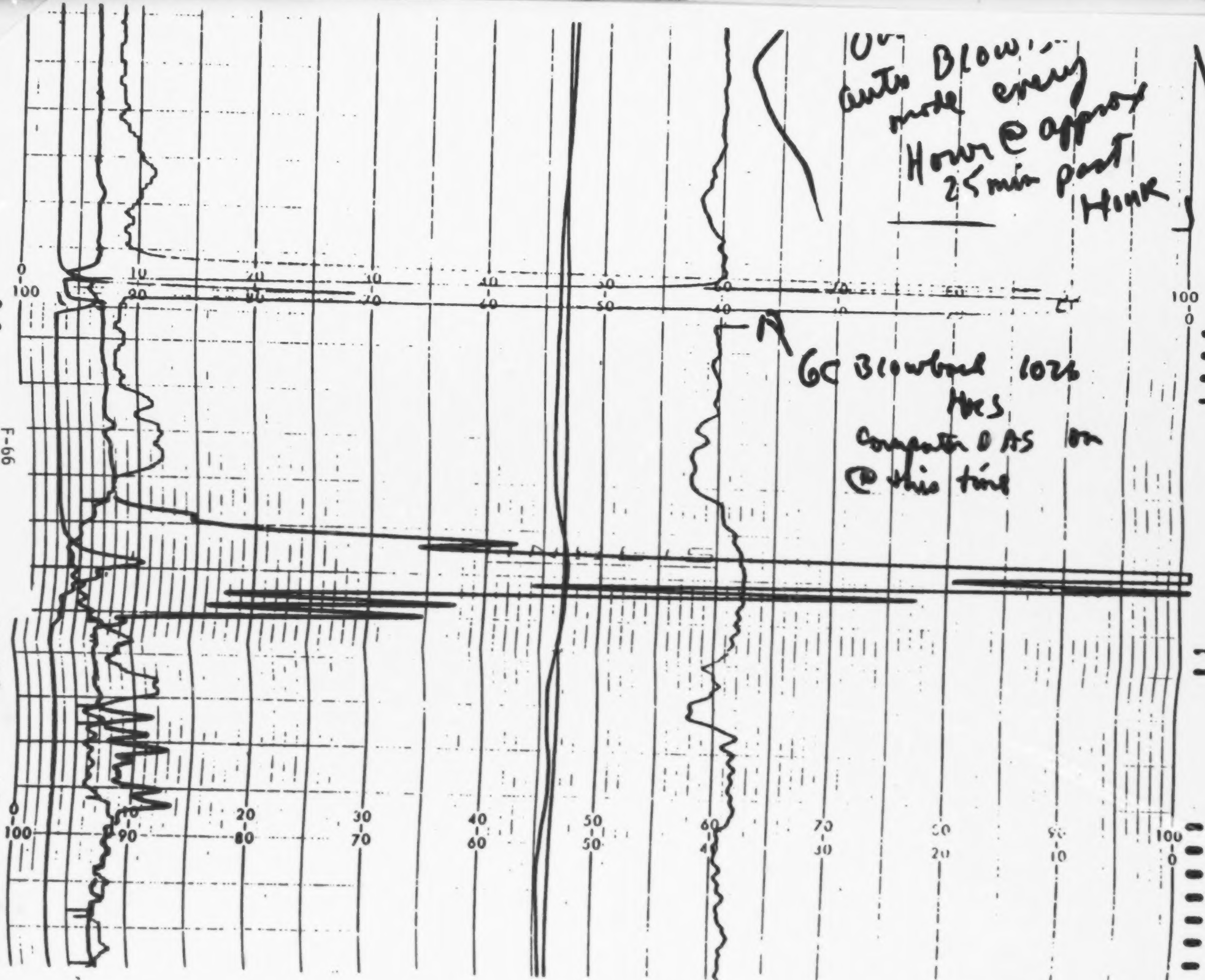

Blowback 12:24 hrs
12:08 hrs
Feed START
% O. Coal
30th 2 pumping
1214 hrs
12:11 hrs
CO2
T1
T2
O2
CO
THC
0
10
20
30
40
50
60
70
80
90
100
F-62
U.S.A.


100 0
90 10
80 20
70 30
60 40
50 50
40 60
30 70
20 80
10 90
0 100
1142hrs
1214 hrs


100 0
90 10
80 20
70 30
60 40
50 50
40 60
30 70
20 80
10 90
0 100
17 Kenbac
1124 hrs
Printed in U.S.A.



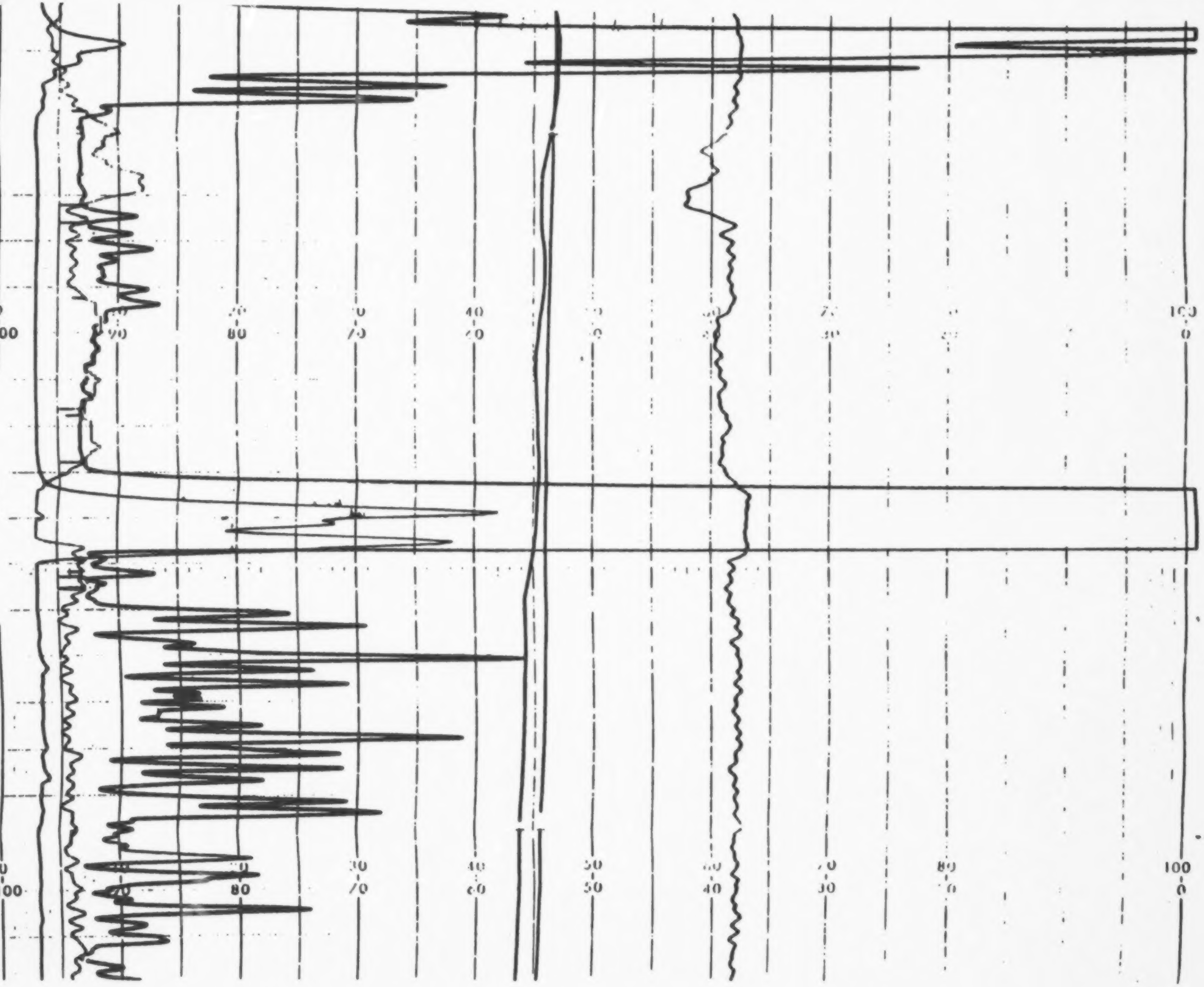
Gas condit on
auto BLOW[illegible]
mode every
— approx

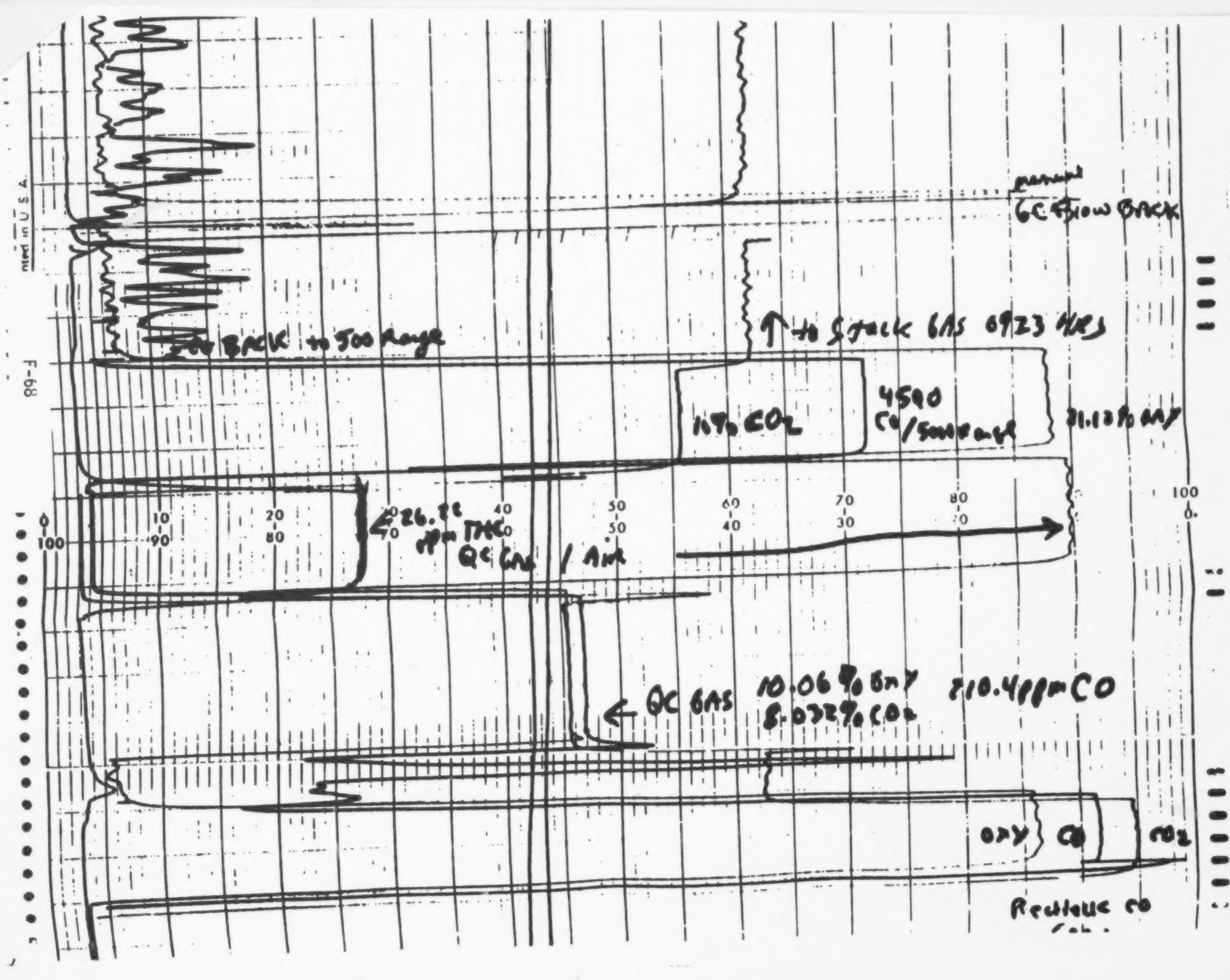


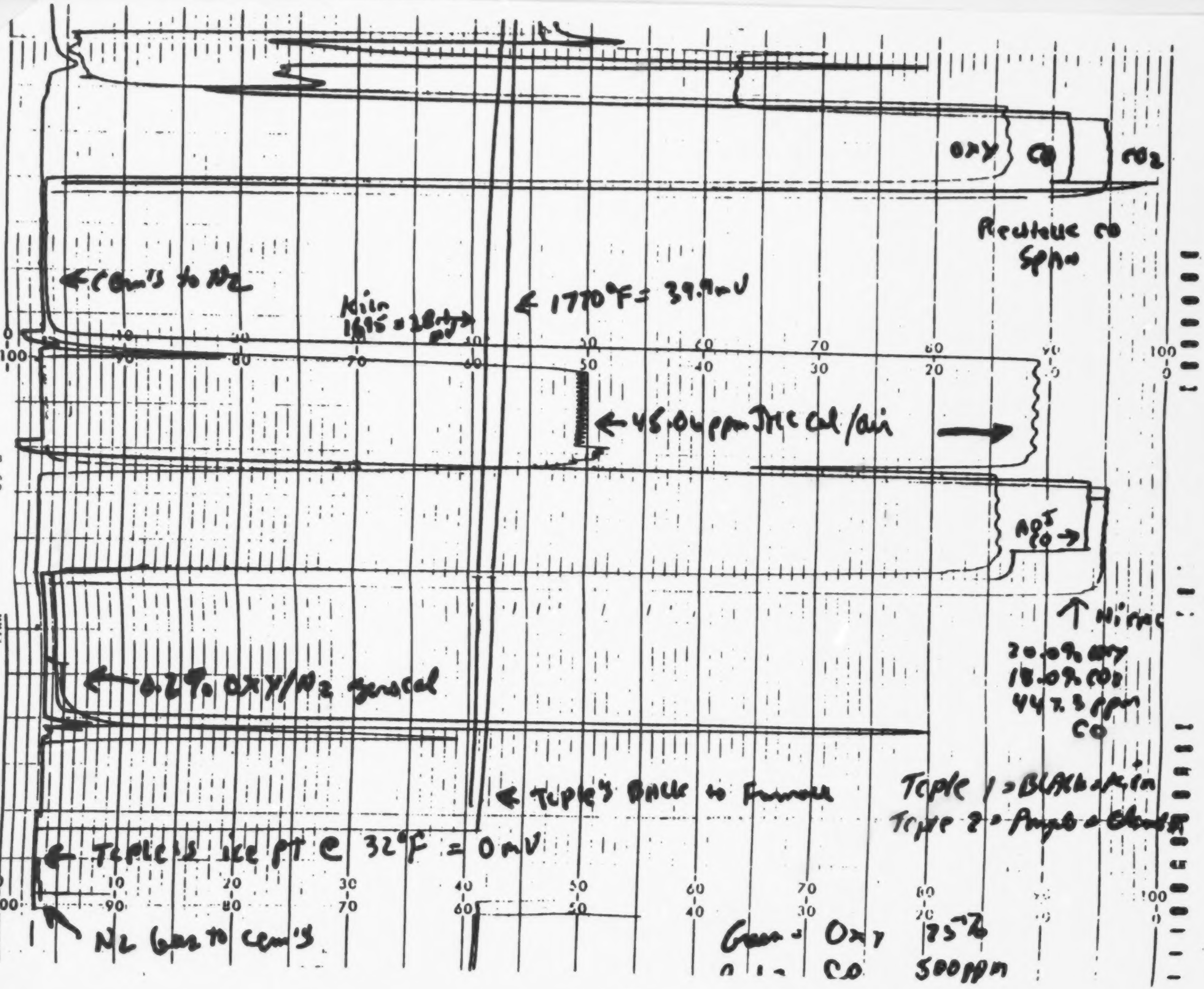
On auto Blow
mode every
Hour @ approx
25 min past
Hour

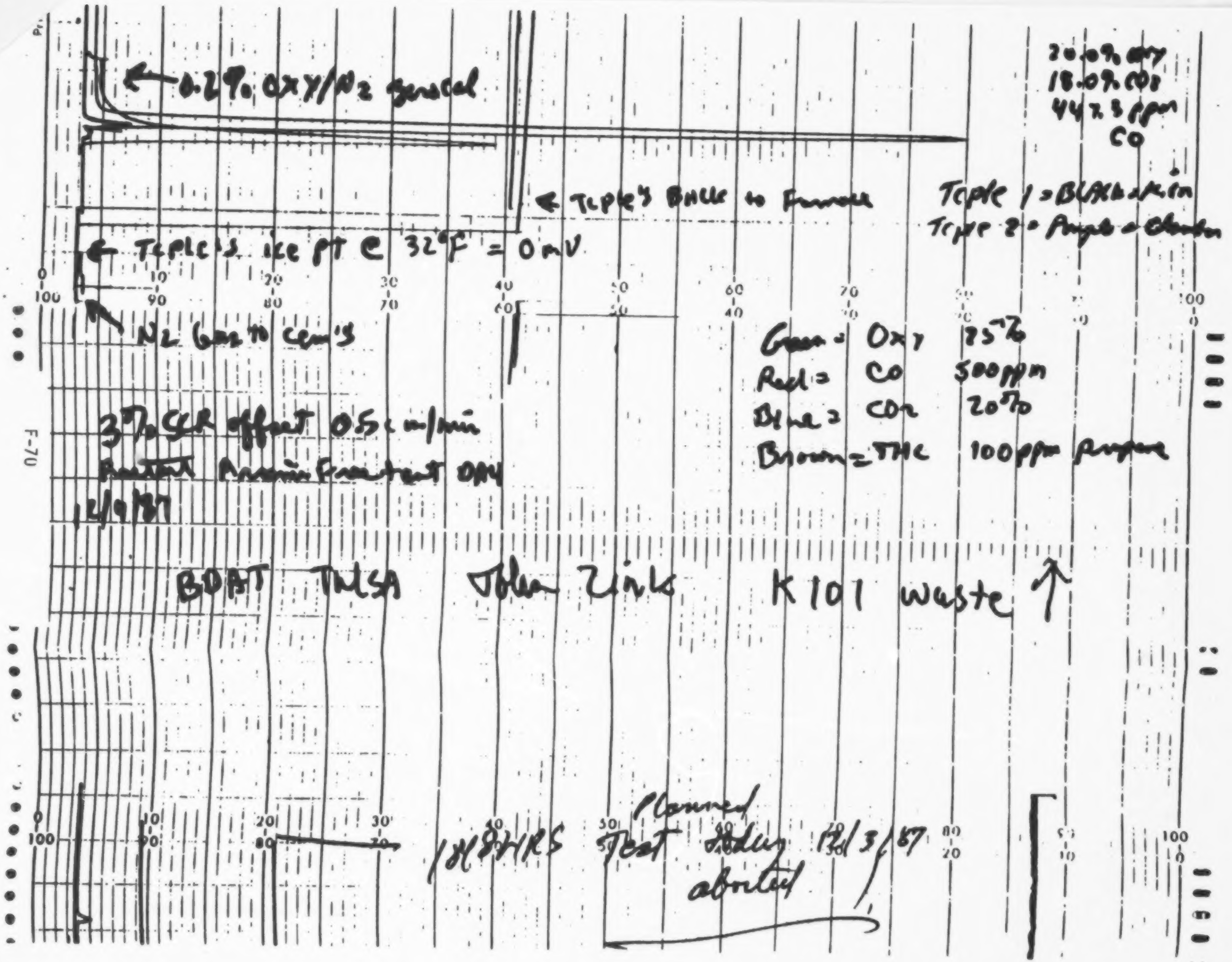
GC Blowback 1026
Hrs
Computer DAS on
@ this time

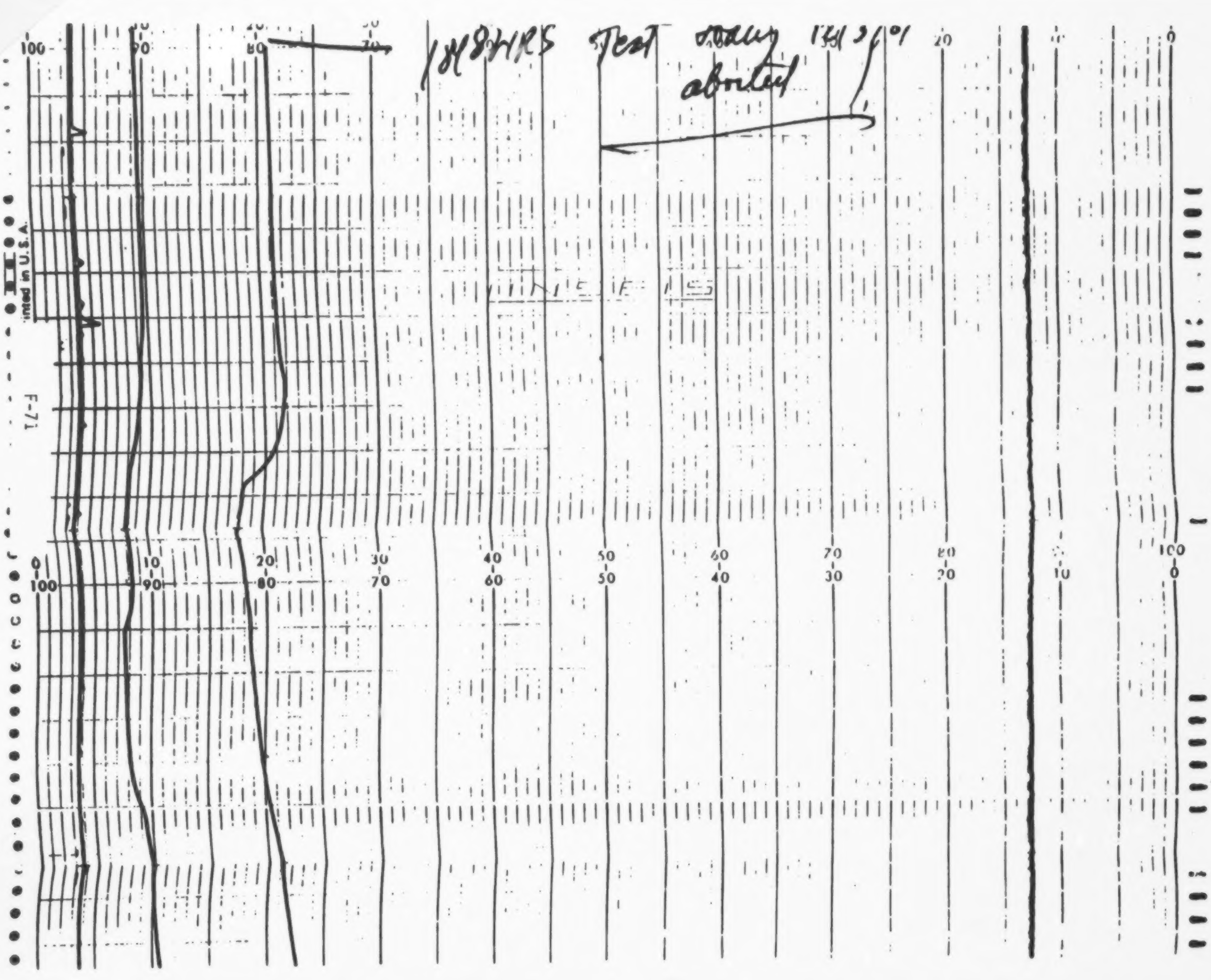
Printed



manual
GC Flow BACK
↑ to Stack GAS 0923 HRS
Set BACK to 500 Range
11% CO2
4590
CO/5000 range
21.12% oxy
← 26.88 ppm THC
QC Gas / Air
← QC GAS 10.06% oxy
8.032% CO2
810.4 ppm CO
oxy
CO
CO2
Residue CO
Cal.
0 10 20 30 40 50 60 70 80 100
100 90 80 70 60 50 40 30 20 0
Printed in U.S.A.

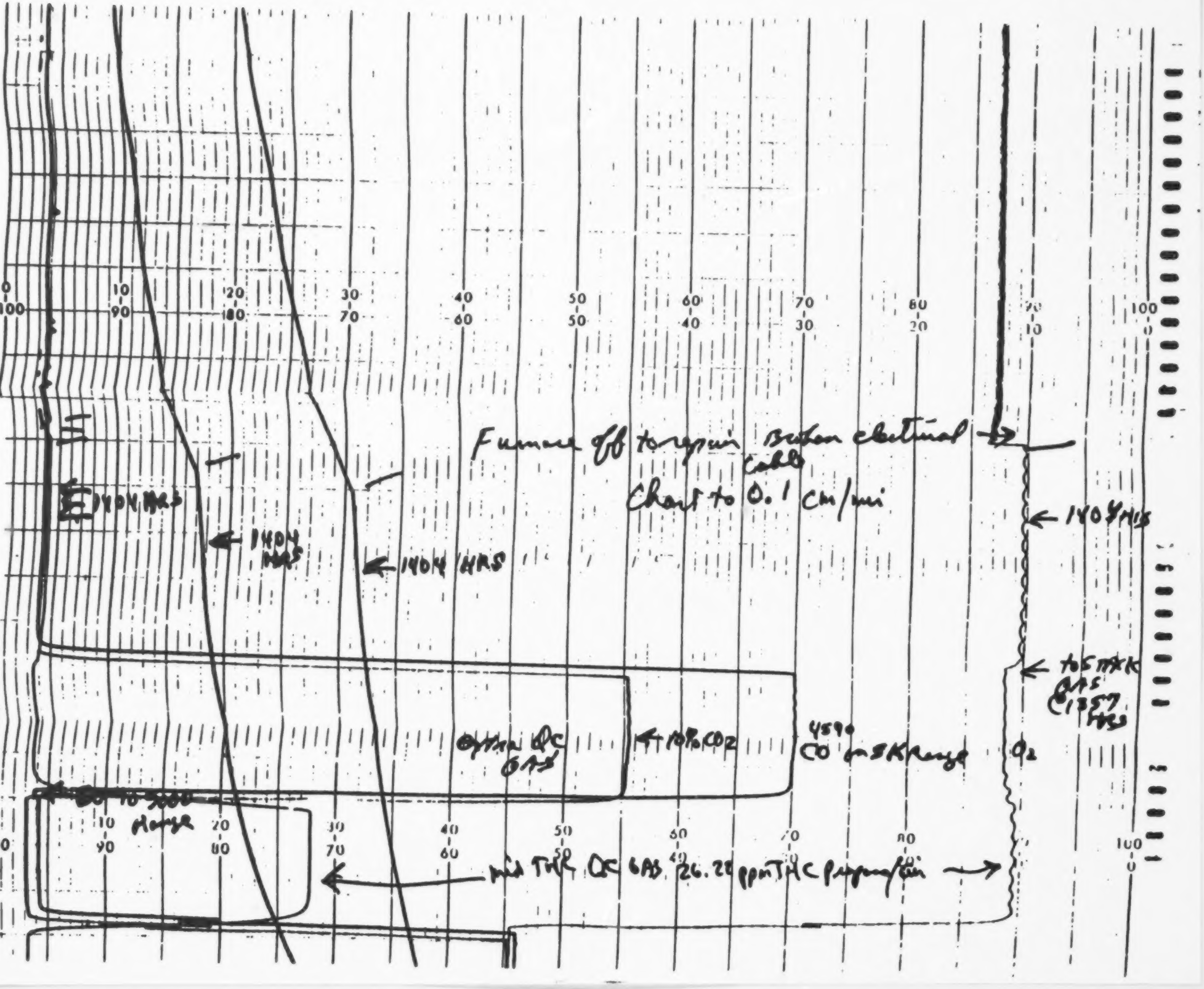

OXY
CO
CO2
Residue CO 5ppm
← CEM's to N2
Kiln 1695 = 38 mv →
← 1770°F = 39.9 mV
← 45.04 ppm THC Cal/air
→
NO_x CO →
↑ Hi THC
20.0% oxy
18.0% CO2
447.3 ppm CO
← 0.2% OXY/N2 Zero cal
← Tcple's Back to Furnace
Tcple 1 = Black + Kiln
Tcple 2 = Purple + Chamber
← Tcple's ice pt @ 32°F = 0 mV
N2 Gas to CEM's
Gas = Oxy 7.5%
CO 500ppm
0
10
20
30
40
50
60
70
80
90
100
Print

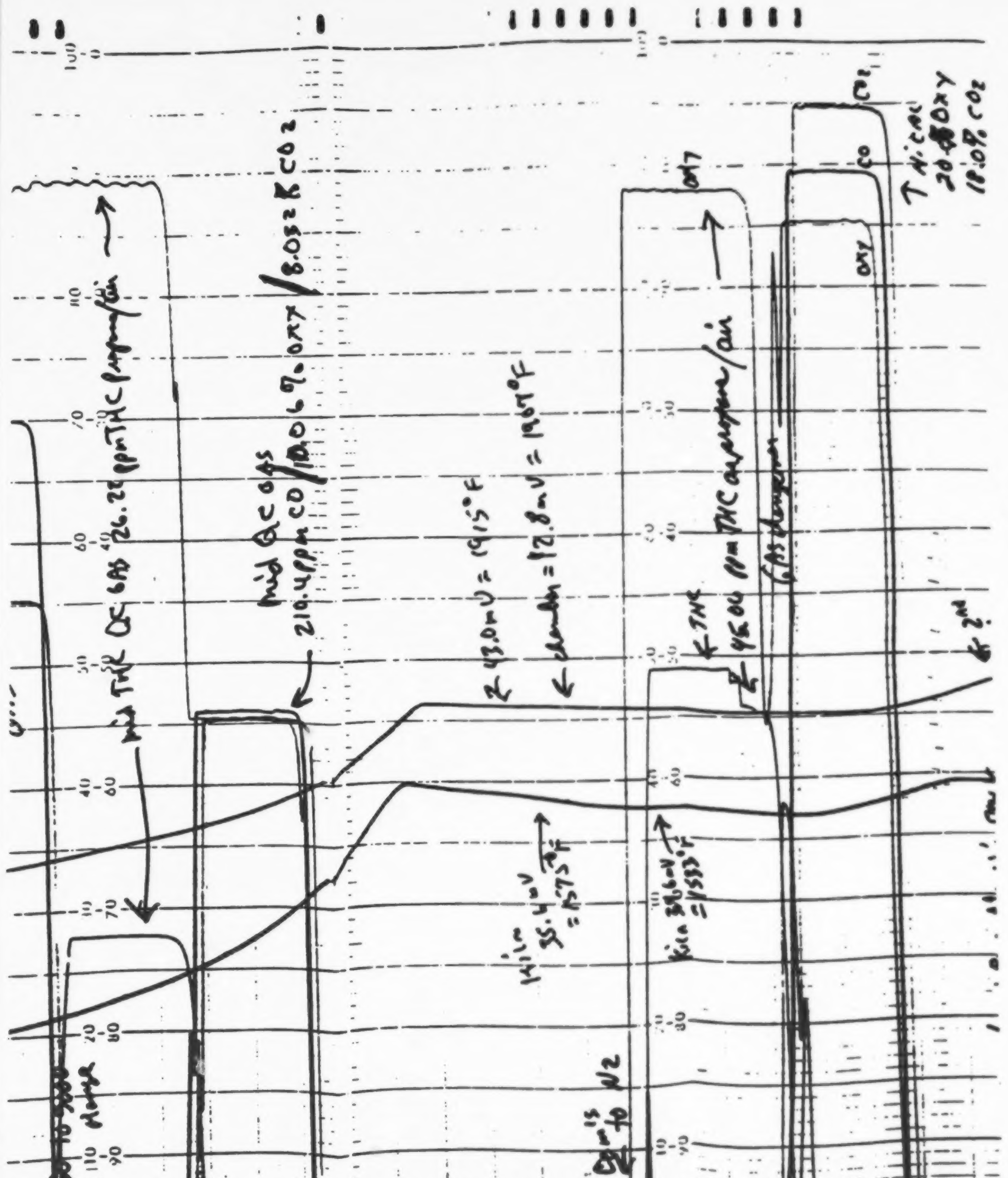
20.0% OXY
18.0% CO2
44.3 ppm CO
← 0.2% OXY/N2 General
← Tcple's Back to Furnace
Tcple 1 = Black = Main
Tcple 2 = Purple = Chamber
← Tcple's ice pt @ 32°F = 0 mV
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
N2 Gas to CEM's
Green = OXY 25%
Red = CO 500 ppm
Blue = CO2 20%
Brown = THC 100 ppm propane
3% CGR offset 0.5 cm/min
Restart Ammonia Pretest DAY
12/9/87
BDAT Tulsa John Zink K101 waste ↑
1800 HRS Test Planned today 12/3/87 aborted



1808HRS Test totally [illegible]
aborted

F-71


0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
Furnace off to repair broken electrical cable
Chart to 0.1 cm/min
1404 HRS
← 1404 HRS
← 1404 HRS
← 1404 HRS
← to SPAN GAS (1357 HRS)
Oxygen QC GAS
← 18% CO2
4590 CO on 5K Range
O2
CO 10-5000 Range
mid THC QC GAS 26.28 ppm THC propane/air



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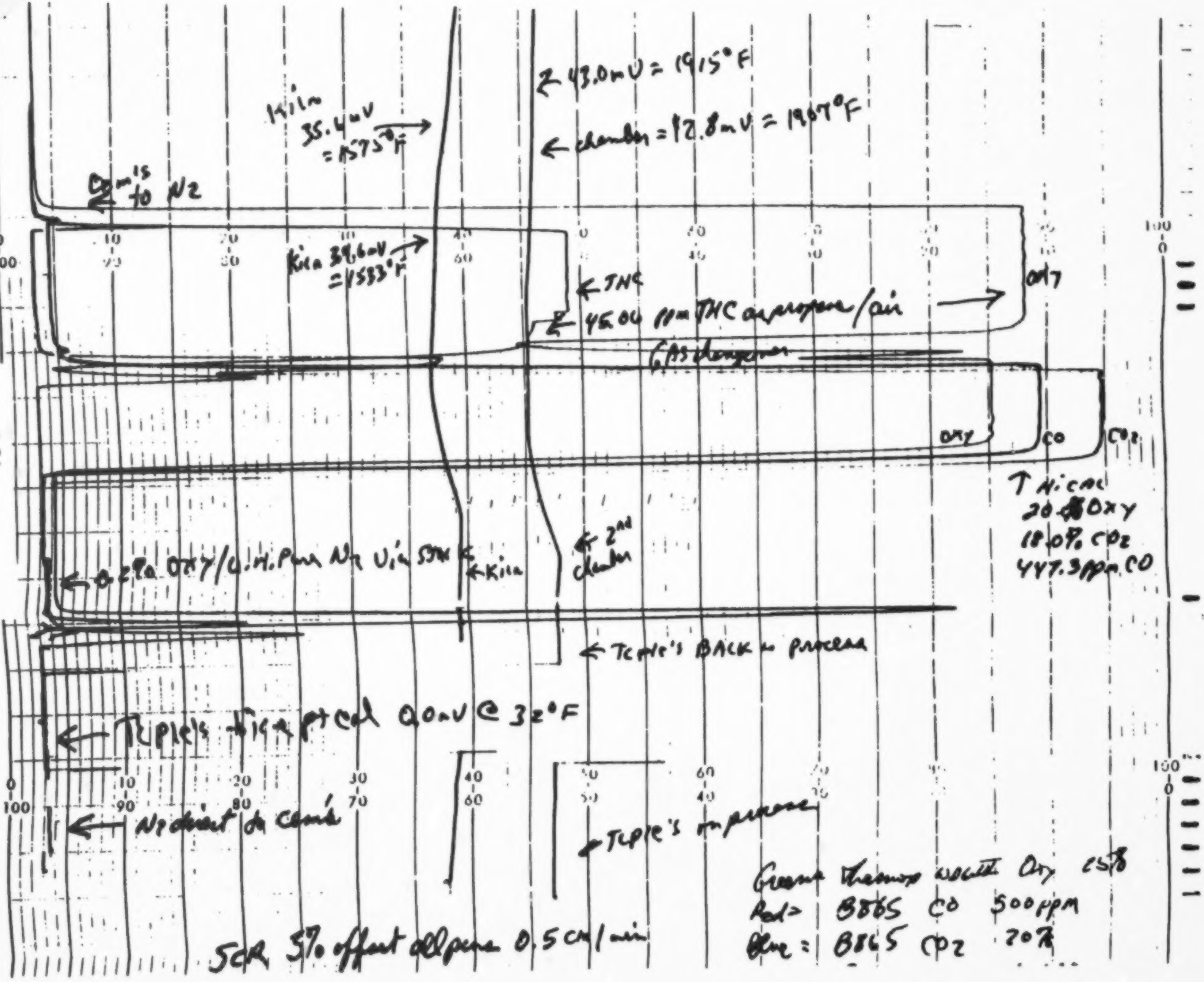
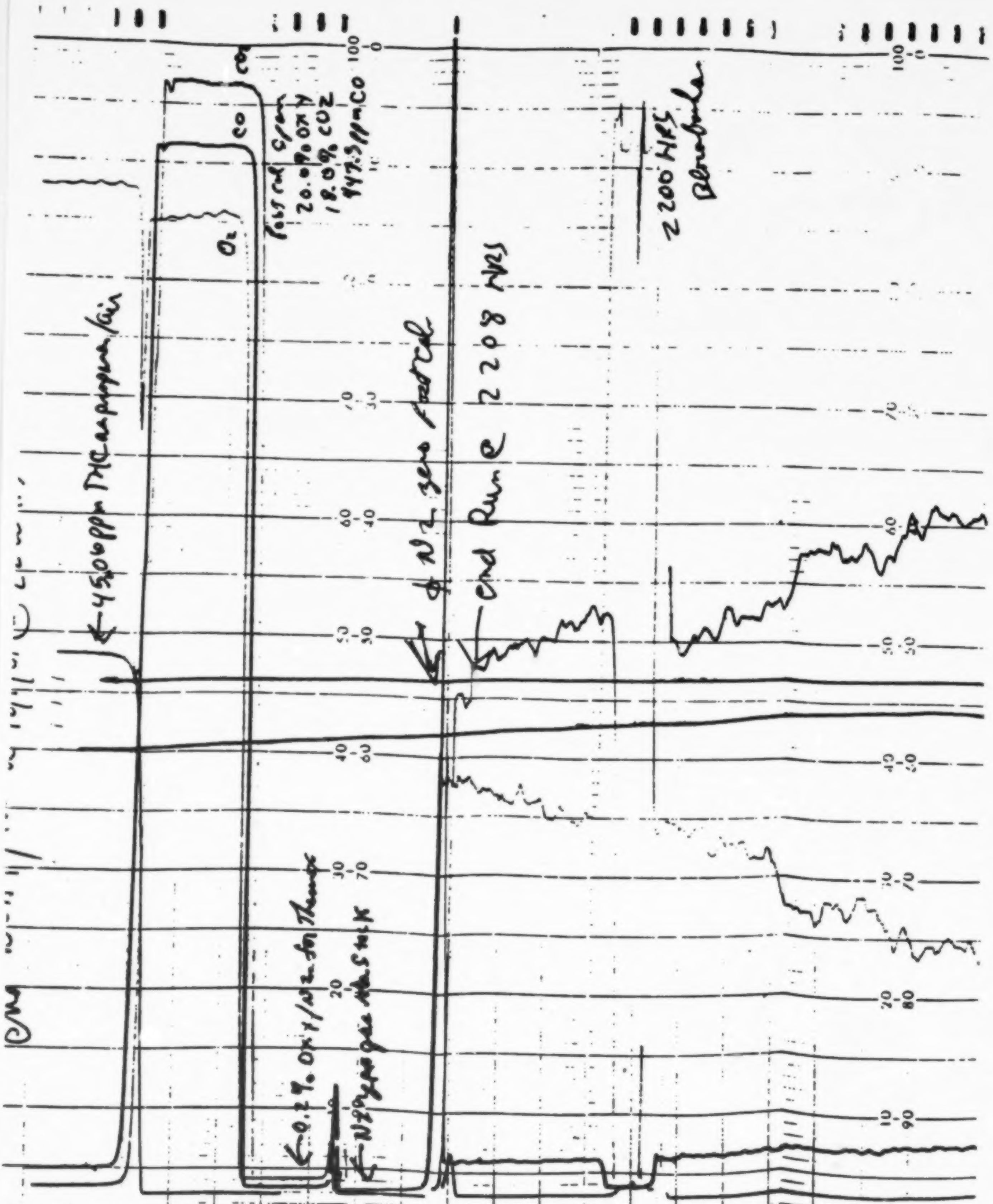
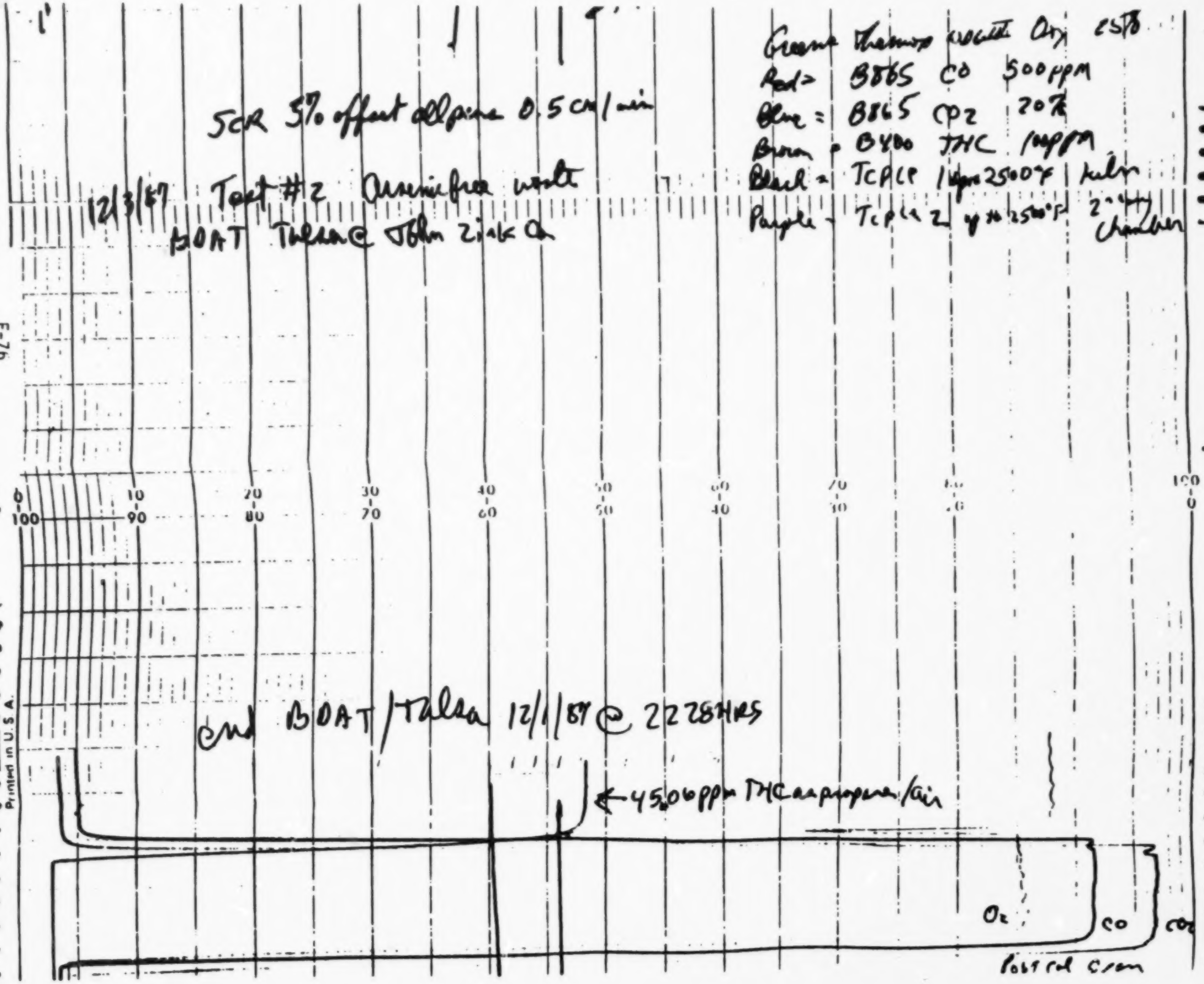

O2 m'ts to N2
Kiln 35.4mV = 1575°F
Z 43.0mV = 1915°F
← chamber = 12.8mV = 1907°F
Kiln 38.6mV = 1533°F
← THC
Z 45.04 ppm THC on propane/air
OXY
Gas changeover
OXY
CO
CO2
↑ Hi cal 20.8 Oxy 18.0% CO2 447.3ppm CO
← 0.2% OXY/U.H.Pure N2 via stack
← Kiln
← 2nd chamber
← T'ple's BACK to process
← T'ple's high pt cal 0.0mV @ 32°F
← N2 direct to cams
← T'ple's in purge
Green thermox model Oxy 25%
Red = B865 CO 500ppm
Blue = B865 CO2 20%
SCR 5% offset all pens 0.5 cm/min
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0


← 450 ppm THC as propane/air
Post cal Span
20.0% OXY
18.0% CO2
947.5 ppm CO
CO2
CO
O2
← 0.2% OXY/N2 for Thermox
← N2 zero gas into Stack
↓ N2 zero Post Cal
← End Run @ 2208 HRS
2200 HRS
Blowdown
100
0
10
90
20
80
30
70
40
60
50
50
60
40
70
30
100



SCR 5% offset all pens 0.5 cm/min

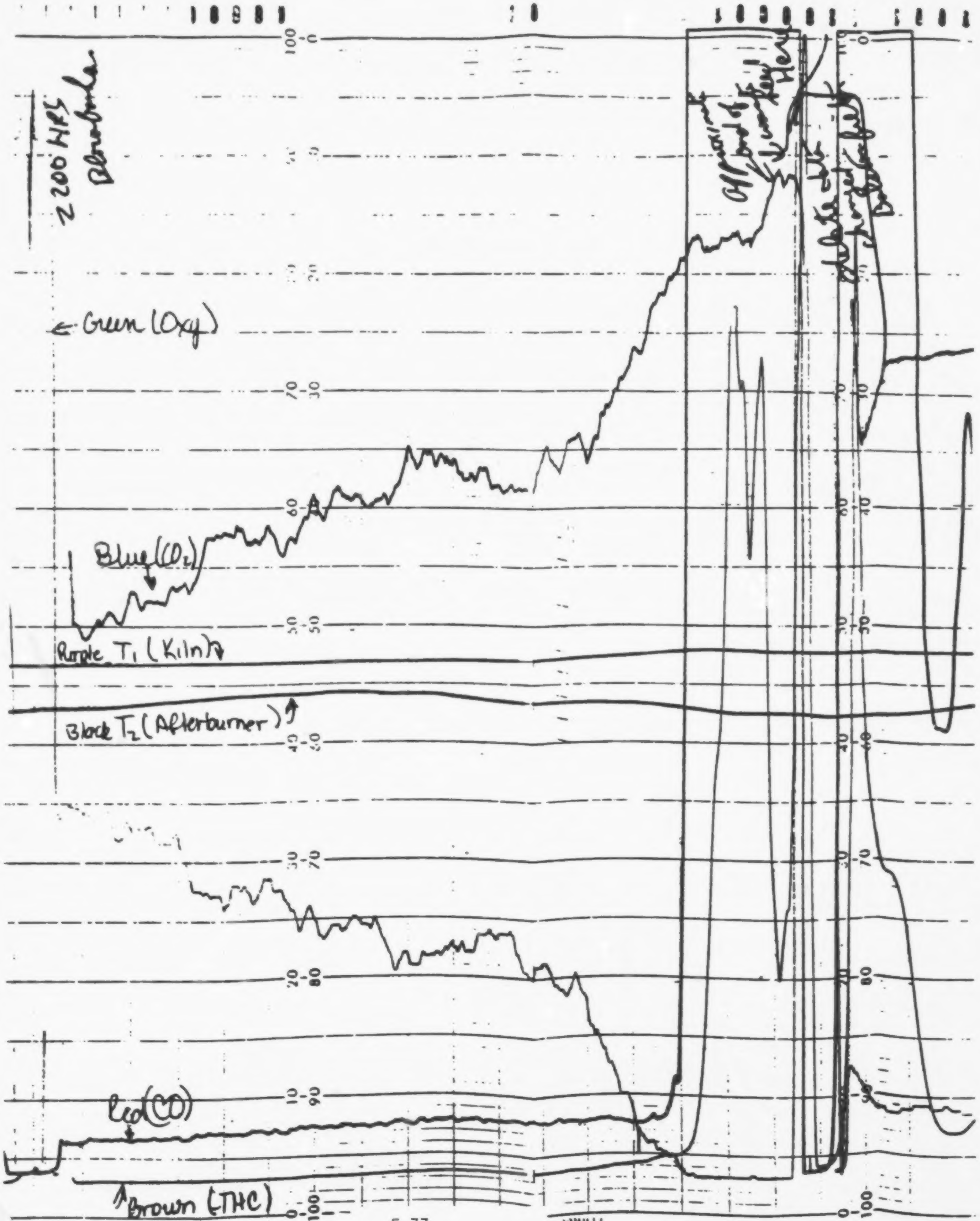
12/3/87 Test #2 Arsenic free waste
BOAT Tulsa @ John Zink Co

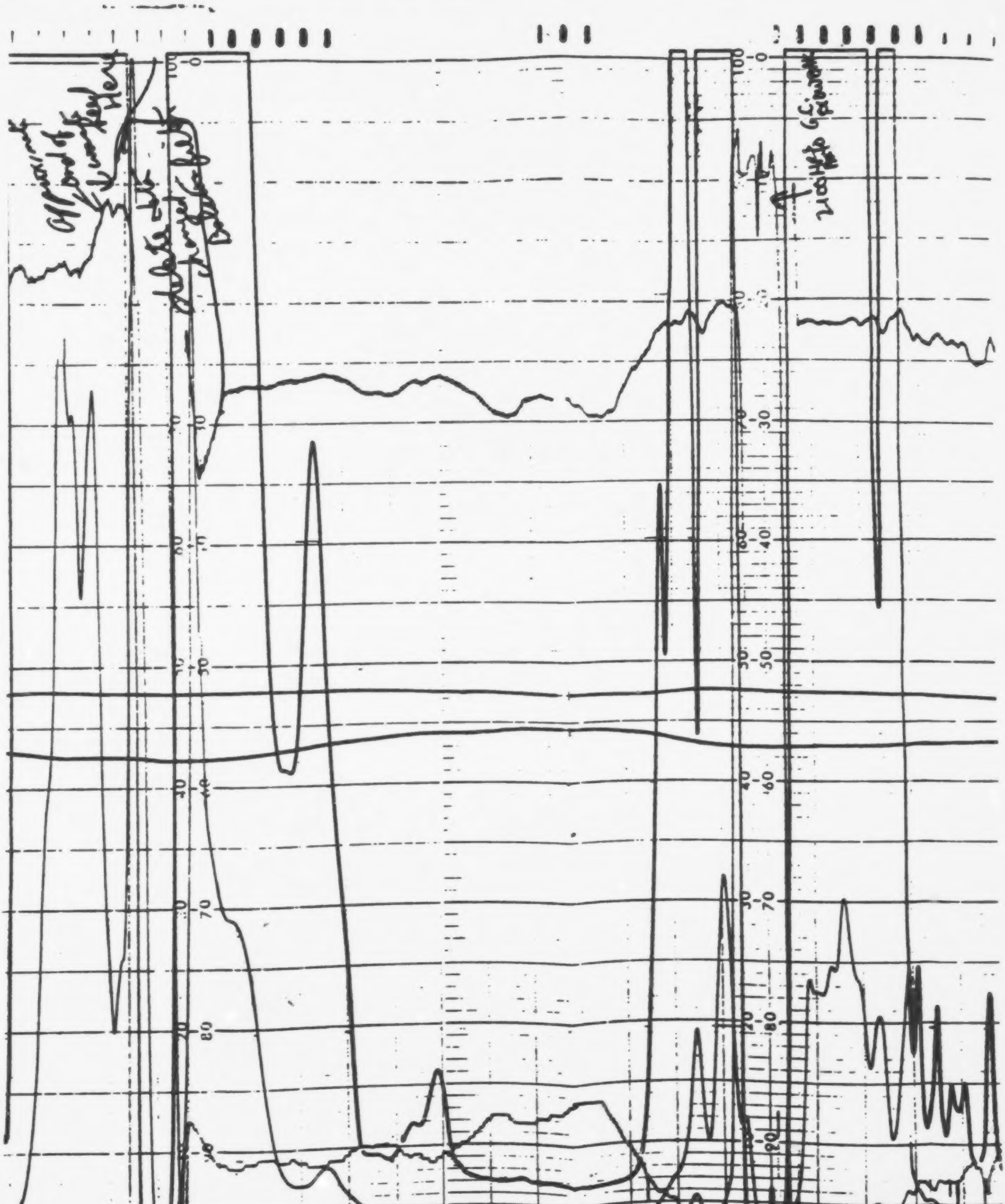
Green thermo electron Oxy ESP8
Red = B865 CO 500 ppm
Blue = B865 CO2 20%
Brown = B400 THC 100ppm
Black = TC#1 1/4 pos 2500°F | kiln
Purple = TC#2 ½ pos 2500°F 2nd chamber

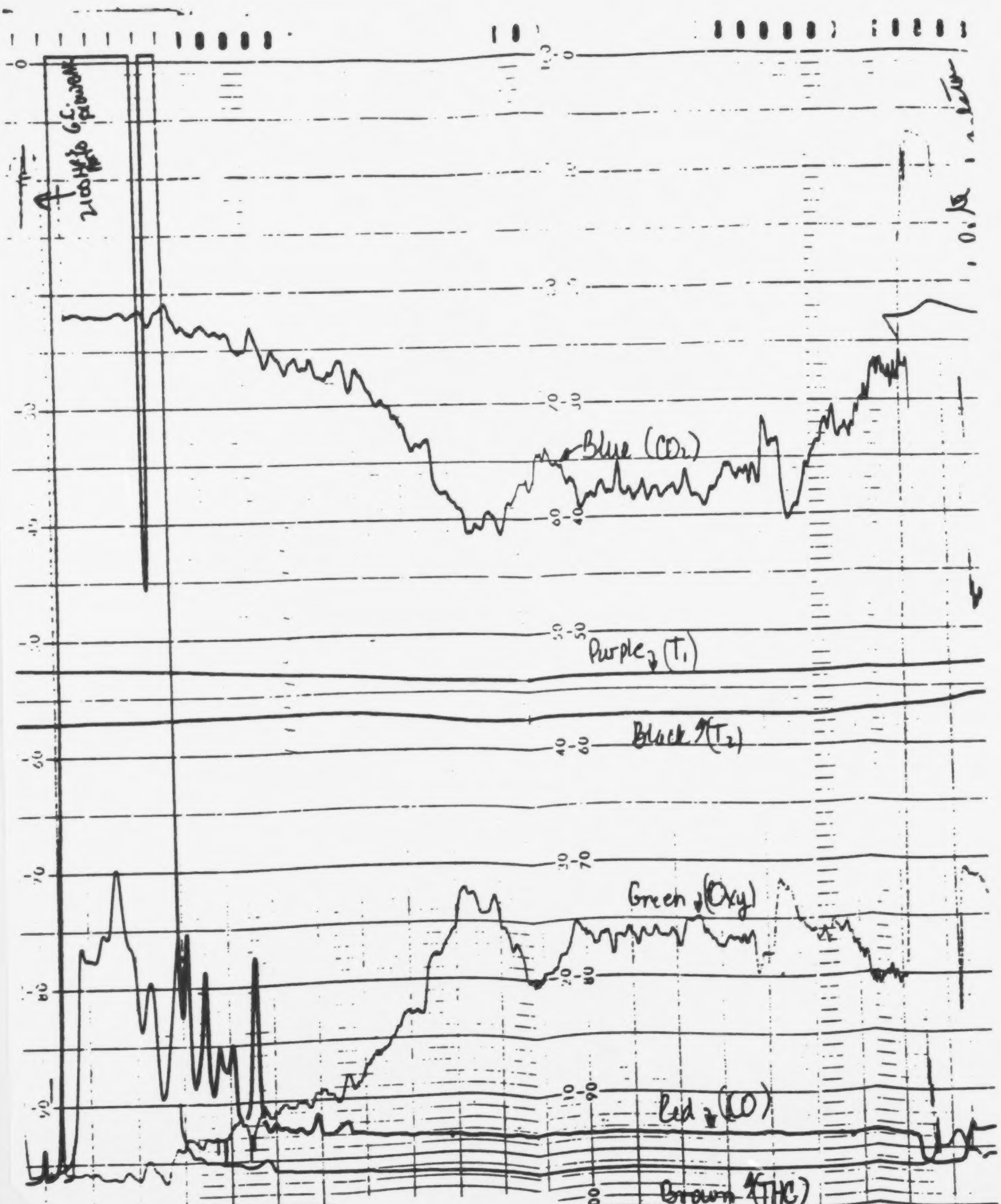
end BOAT/Tulsa 12/1/87 @ 2228 HRS

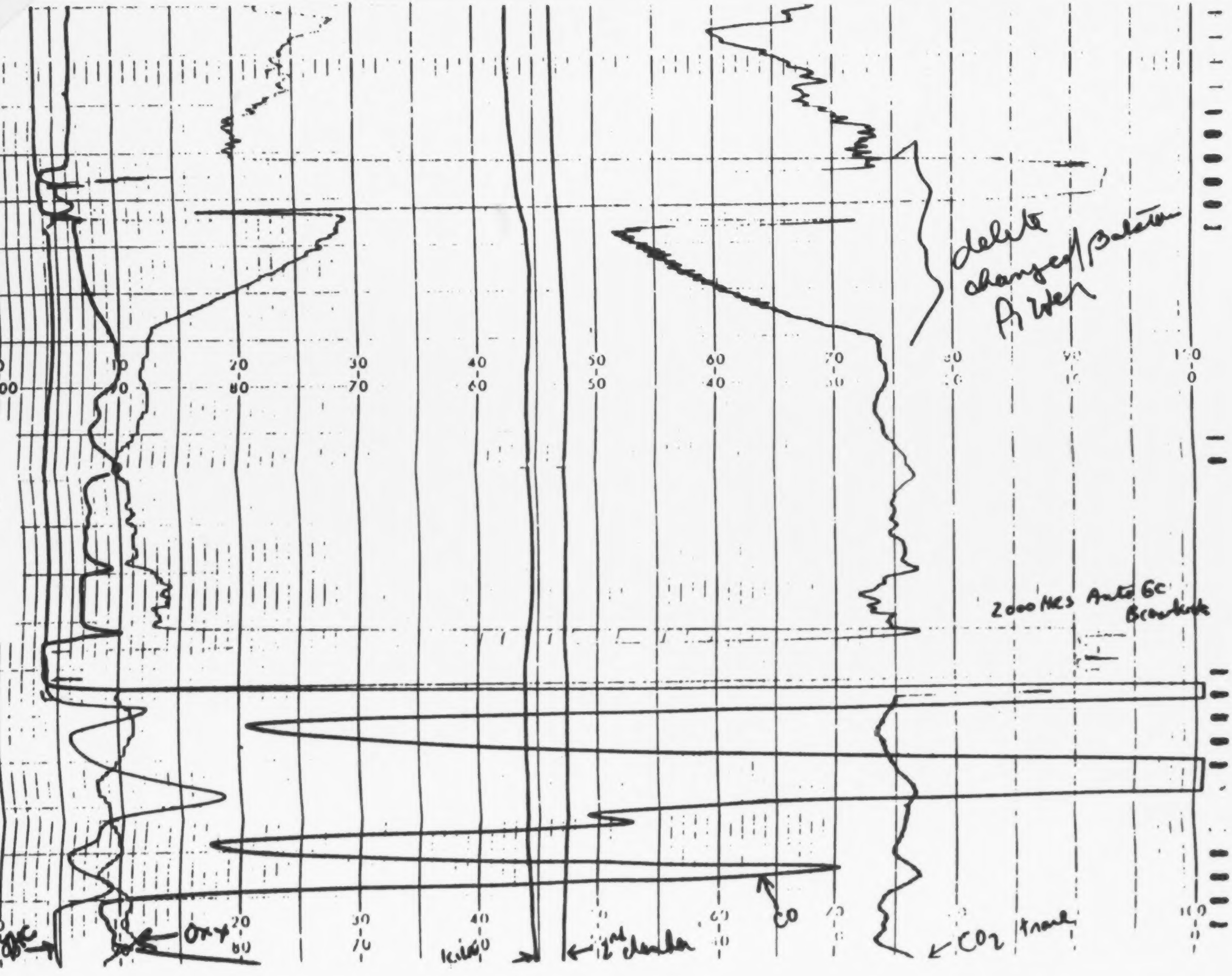
← 4500ppm THC as propane/air

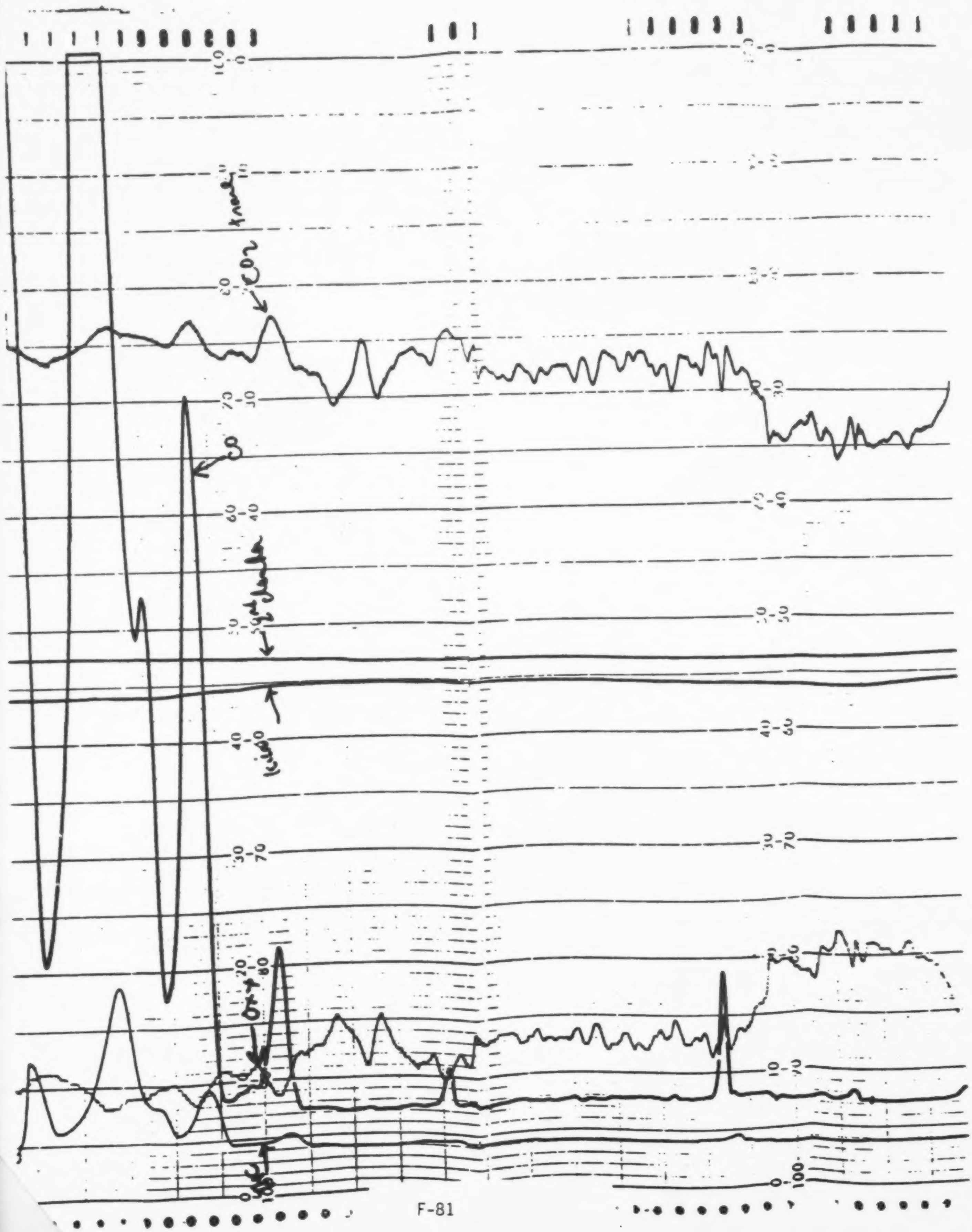
Post cal scan

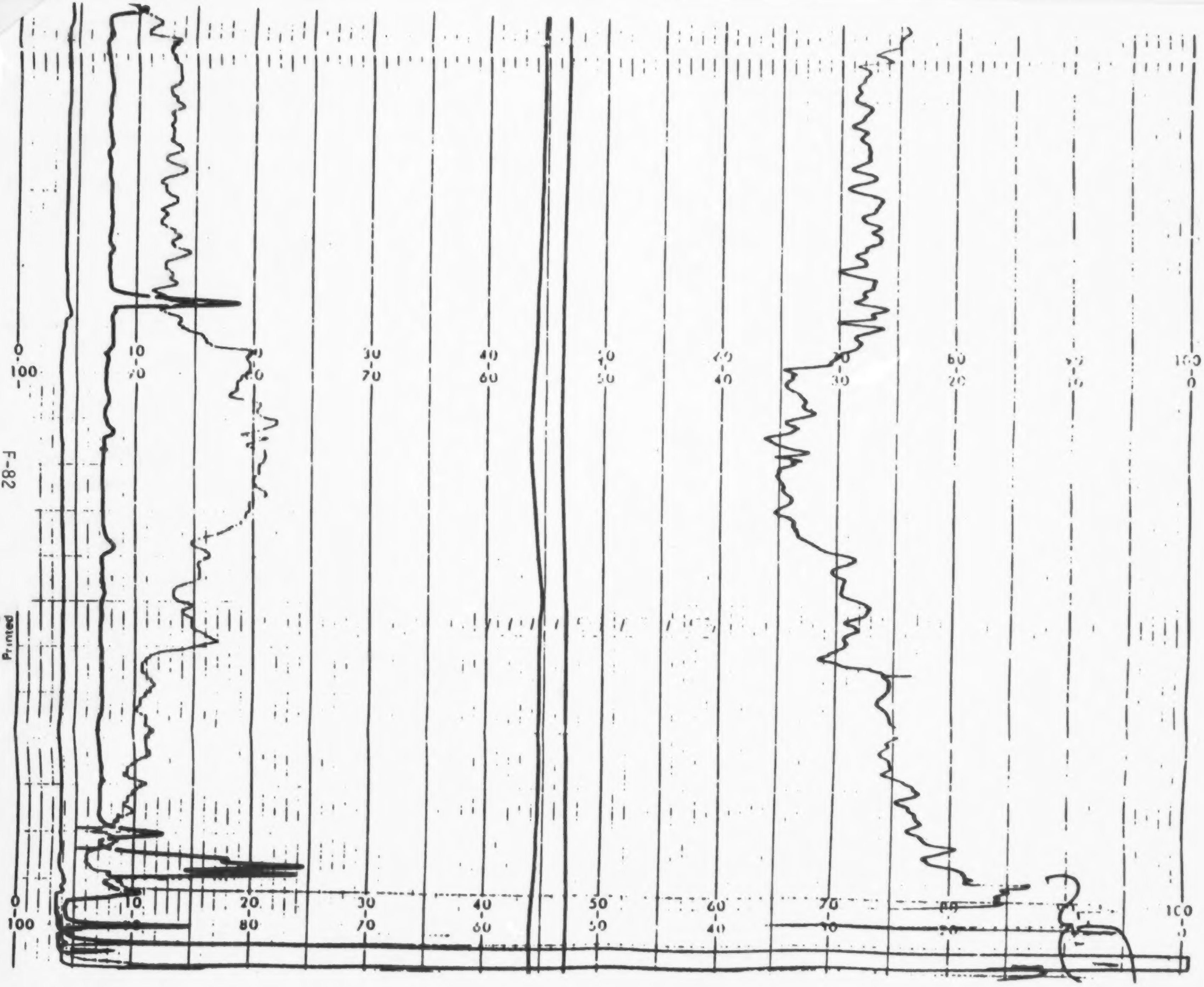

2200 HRS
Blowdown
← Green (Oxy)
Blue (O2)
Purple T1 (Kiln)
Black T2 (Afterburner)
Red (CO)
Brown (THC)
100
90
80
70
60
50
40
30
20
10
0
Heavy

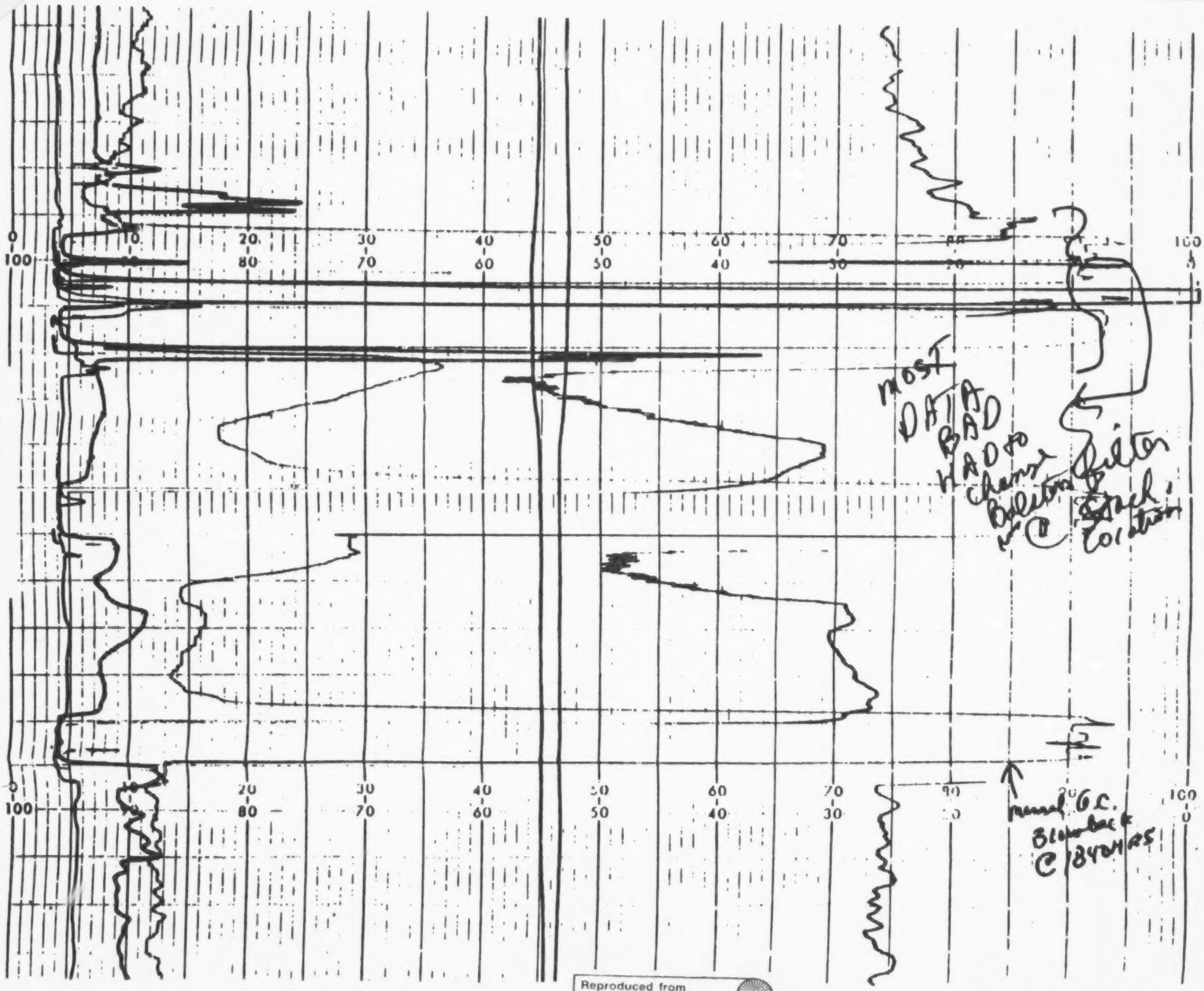

Approximate
end of
Liquid Heavy
Add water while
changed feed
Dumb [illegible]
2400 Hz
to 6 C.i.
[illegible]
0
10
20
30
40
50
60
70
80
90
100


2100 Hrs G.C. blowdown
0
30
40
50
60
70
80
90
100
Blue (CO2)
Purple (T1)
Black (T2)
Green (Oxy)
Red (CO)
Brown (THC)
Printed in U.S.A.


dilute
changed/Balator
2000 HRS Auto GC
Breakdown
0
100
10
90
20
80
30
70
40
60
50
50
60
40
70
30
80
20
90
10
100
0
Printer
THC
Oxy
kiln
2nd chamber
CO
CO2 trace


CO2 trace
CO
3rd chamber
Kiln O
Oxy
100
0
10
20
30
40
50
60
70
80
90


0
100
10
90
20
80
30
70
40
60
50
50
60
40
70
30
80
20
90
10
100
0
Printed



MOST DATA BAD HAD to Change Bulletin filter @ stack location

manual 6 L. Blowback @ 1840 HRS

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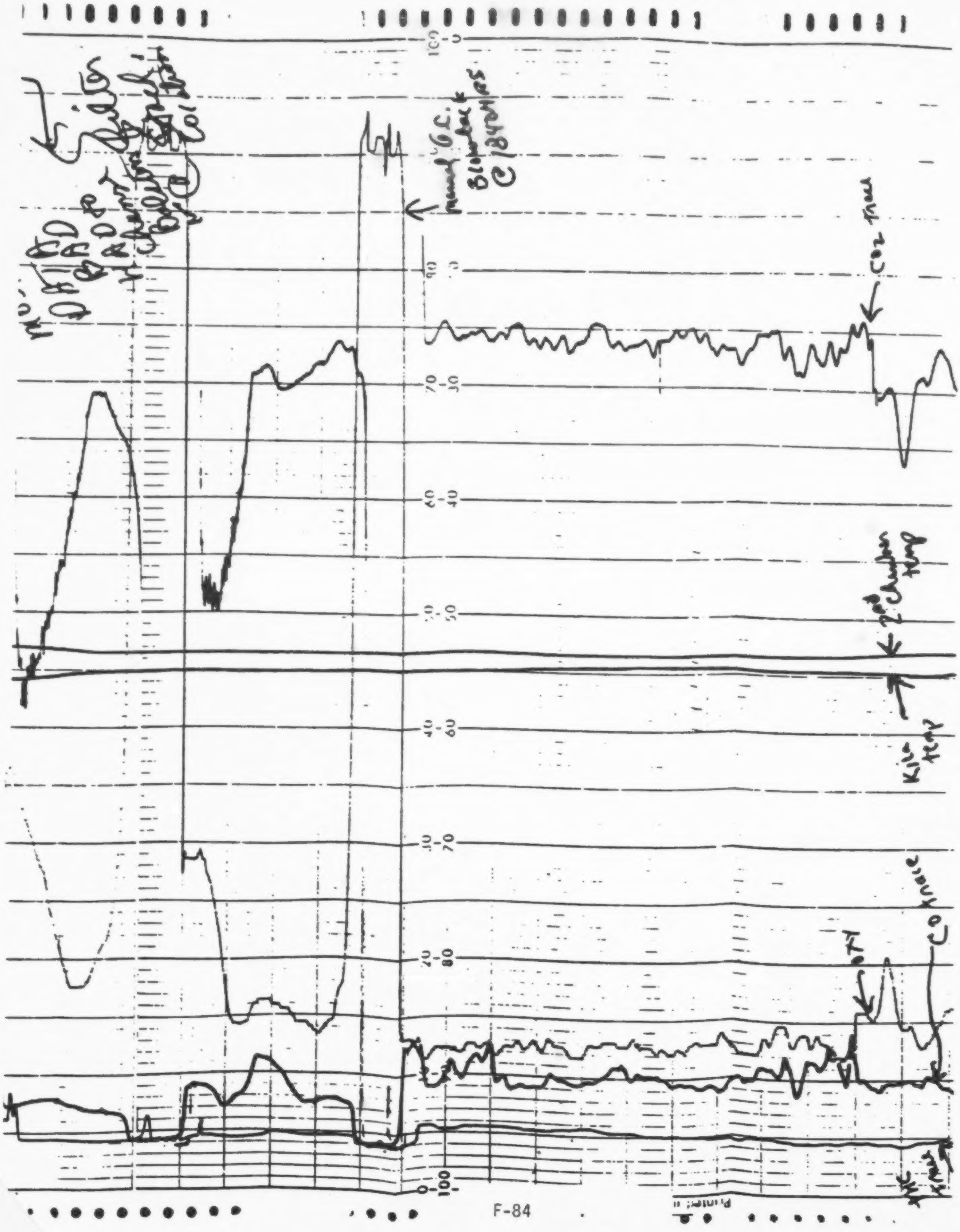
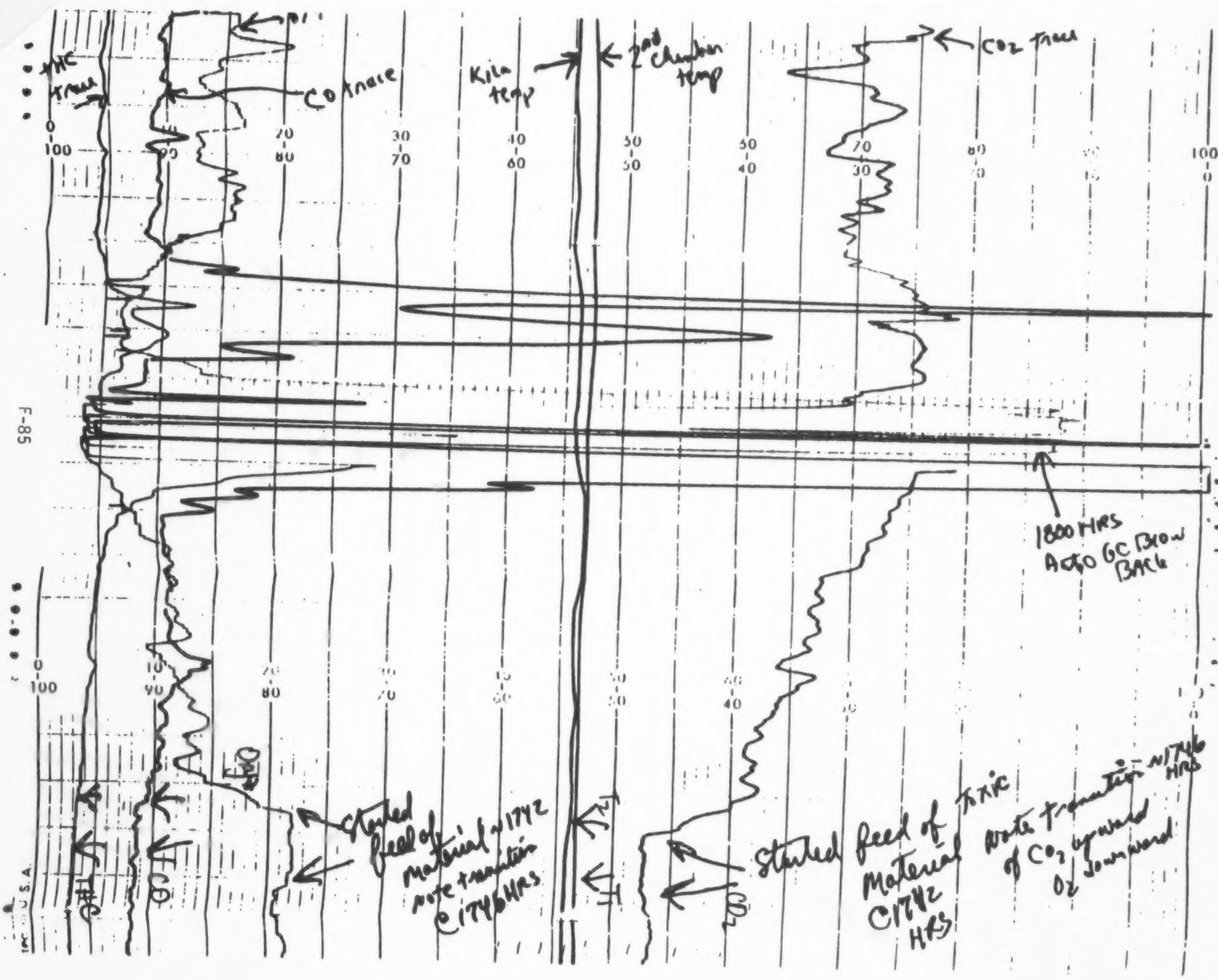
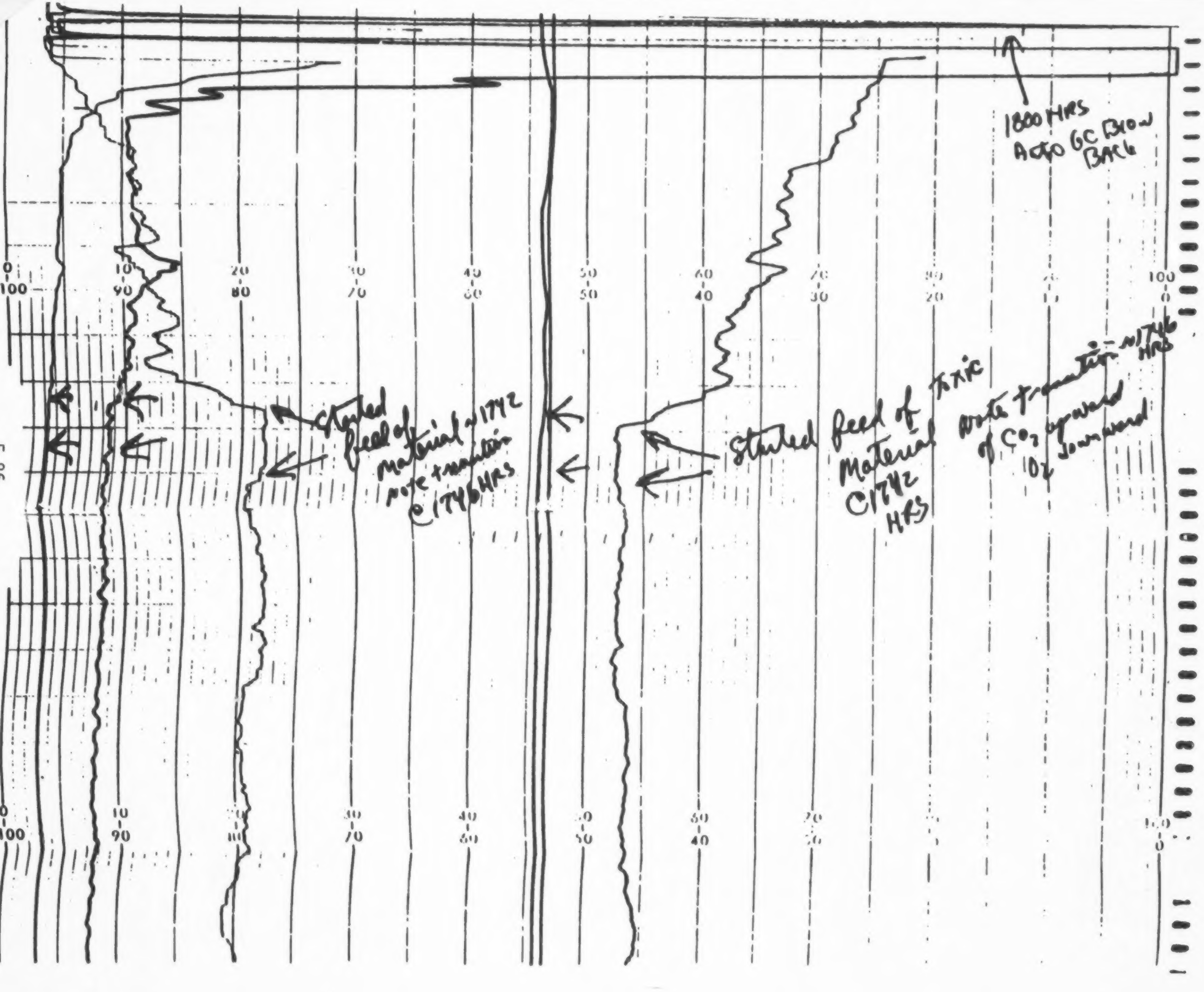
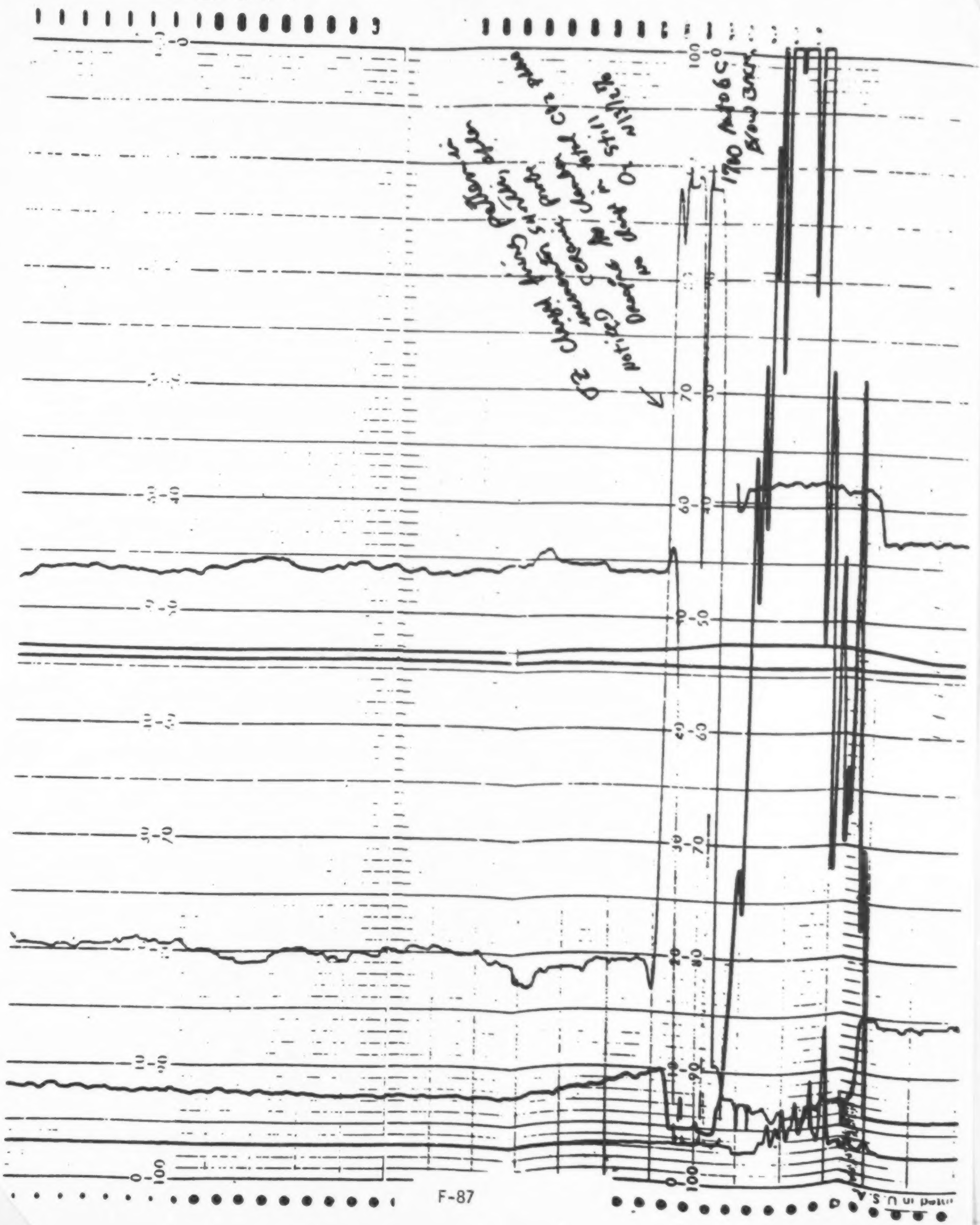
100
90
70 30
60 40
50 50
40 60
30 70
20 80
0 100
CO2 Trace
2nd Chamber Temp
Kiln Temp
CO Trace
Manual G.C. Biomodule @ 1840 hrs
Printer

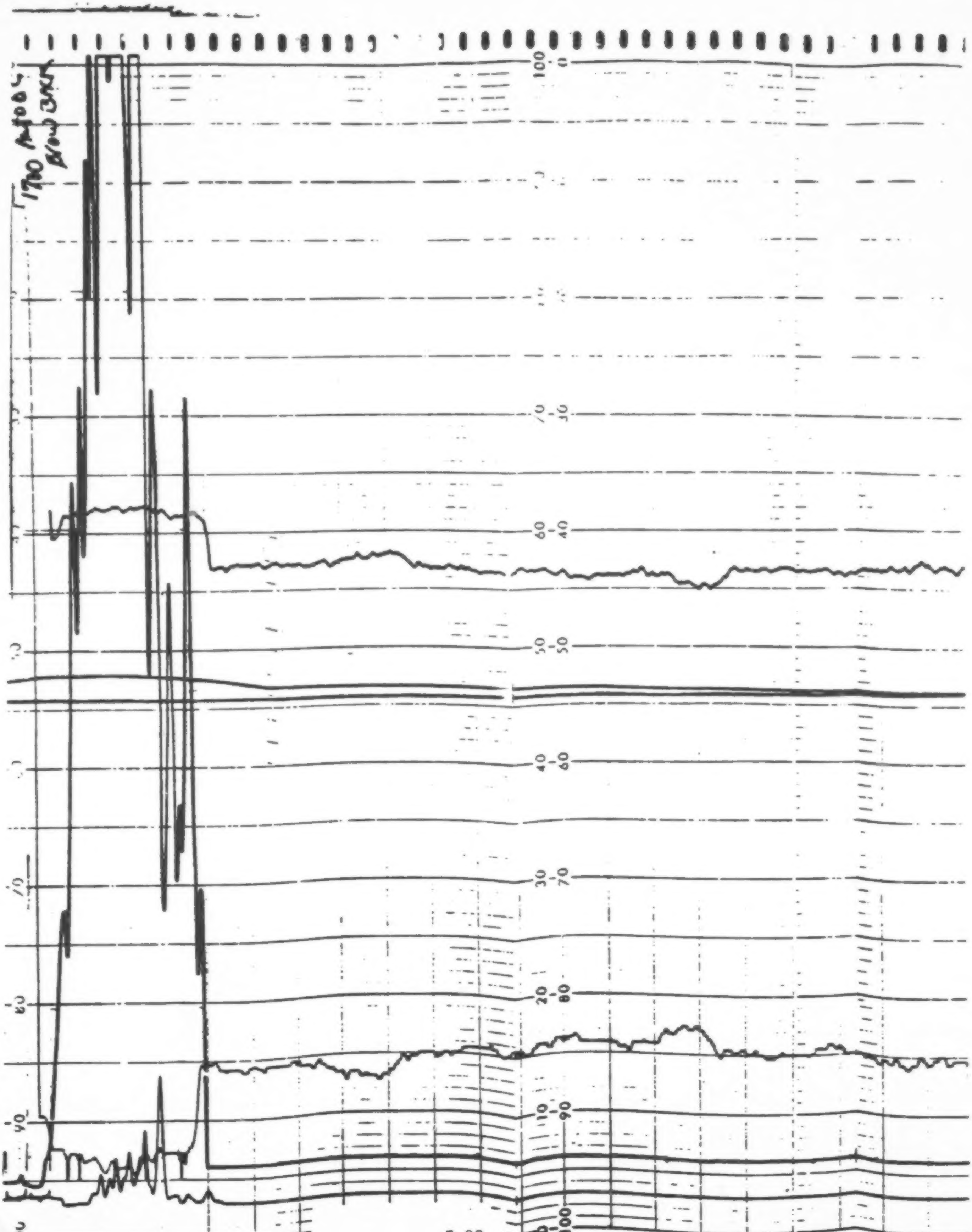

THC trace
CO trace
O2
Kiln temp
2nd Chamber temp
CO2 trace
1800 HRS Auto GC Blow Back
Started feed of material ~1742 note transition @1746 HRS
Started feed of toxic material @1742 HRS note transition ~1746 HRS of CO2 upward O2 downward
T2
T1
CO2
O2
CO
THC
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0

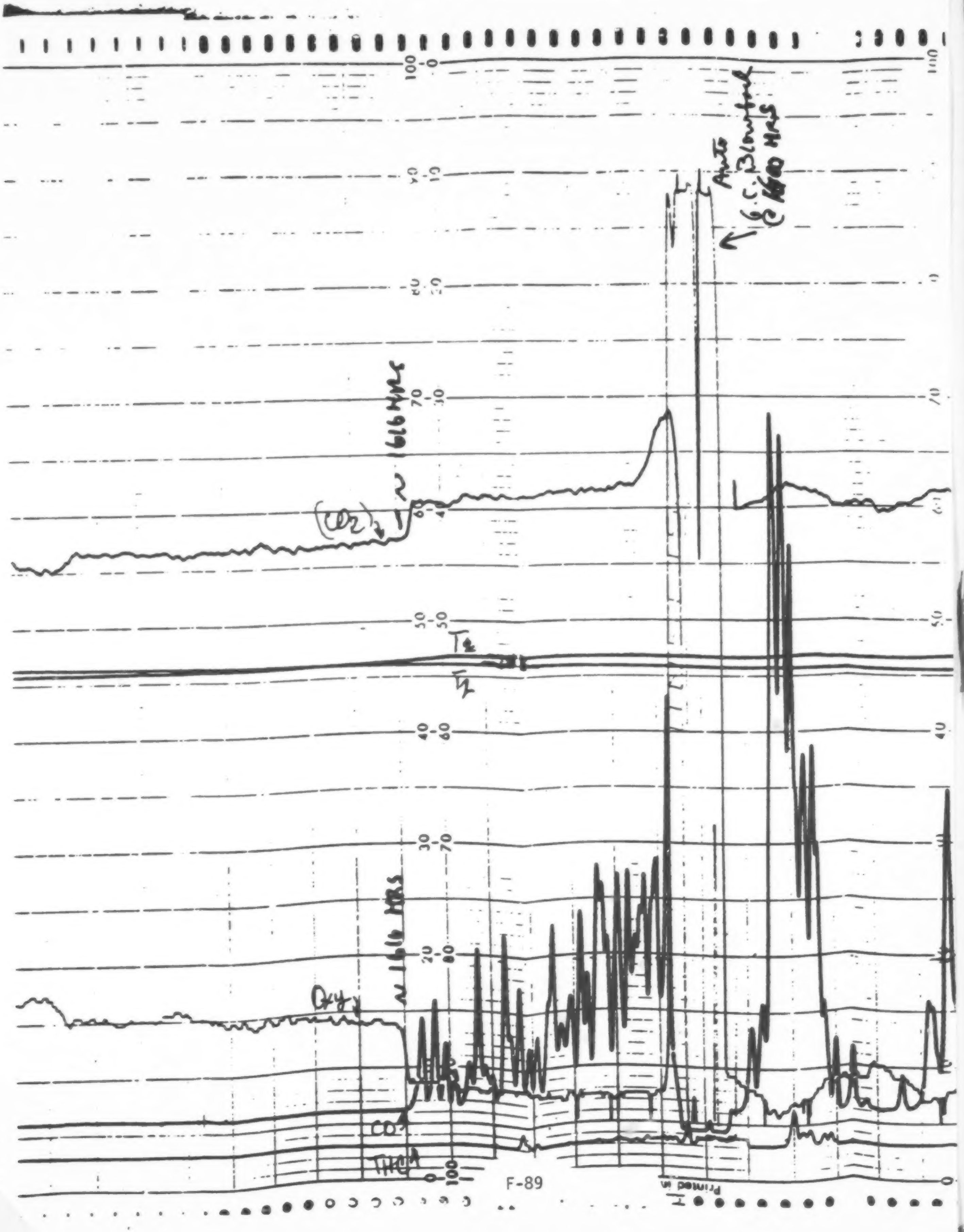

1800 HRS
Auto GC Blow Back
Started feed of toxic Material @1742 HRS
note transition ~1746 HRS of CO_2 upward O_2 downward
Started feed of Material ~1742
note transition @1746HRS
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0



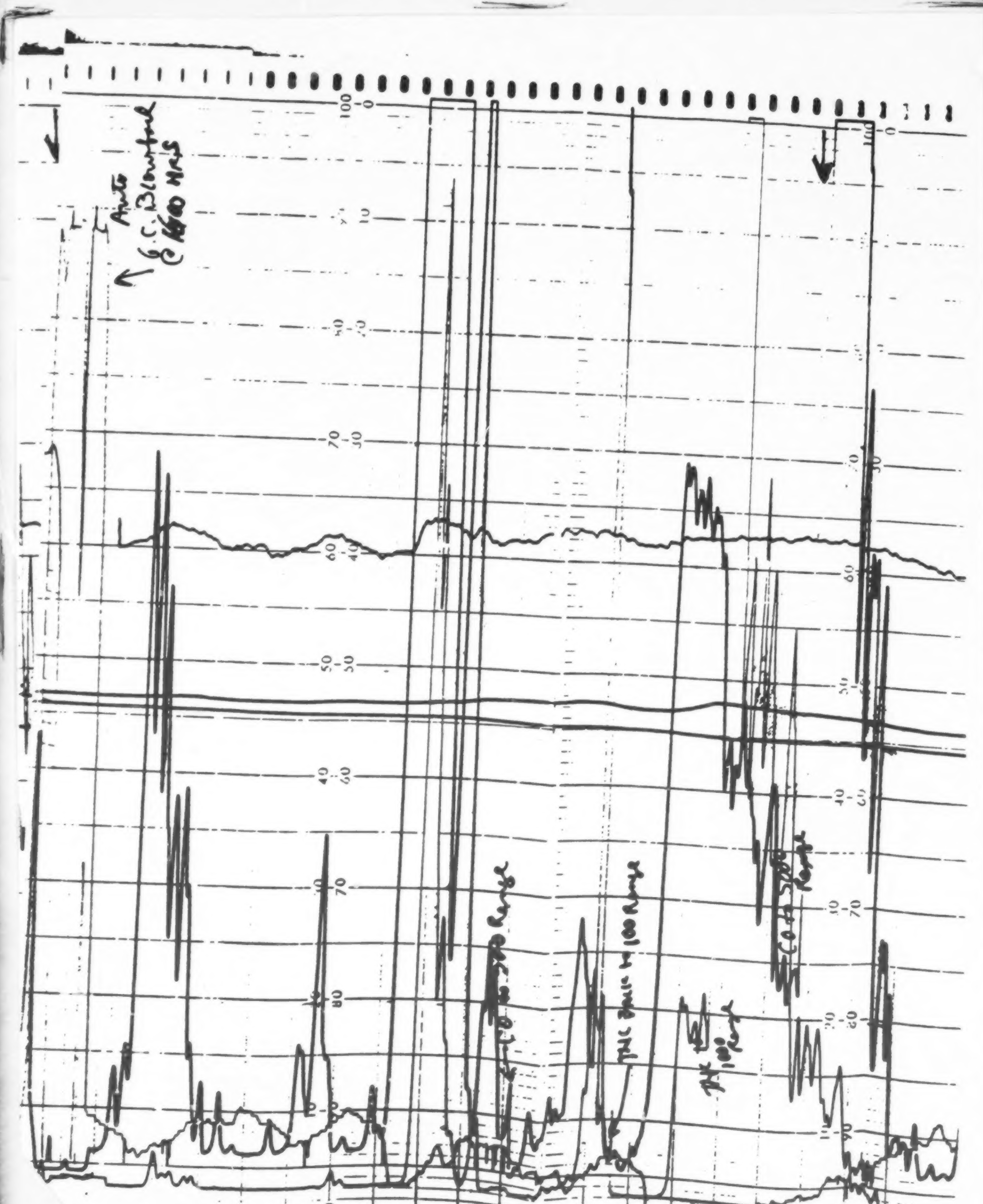
O2 Charted during Pattern is
(Turni) after
minimum for startup purge
Ceronly Chart changed after CV2 purge
← noticed Damper in chart is O2 still n/13/78

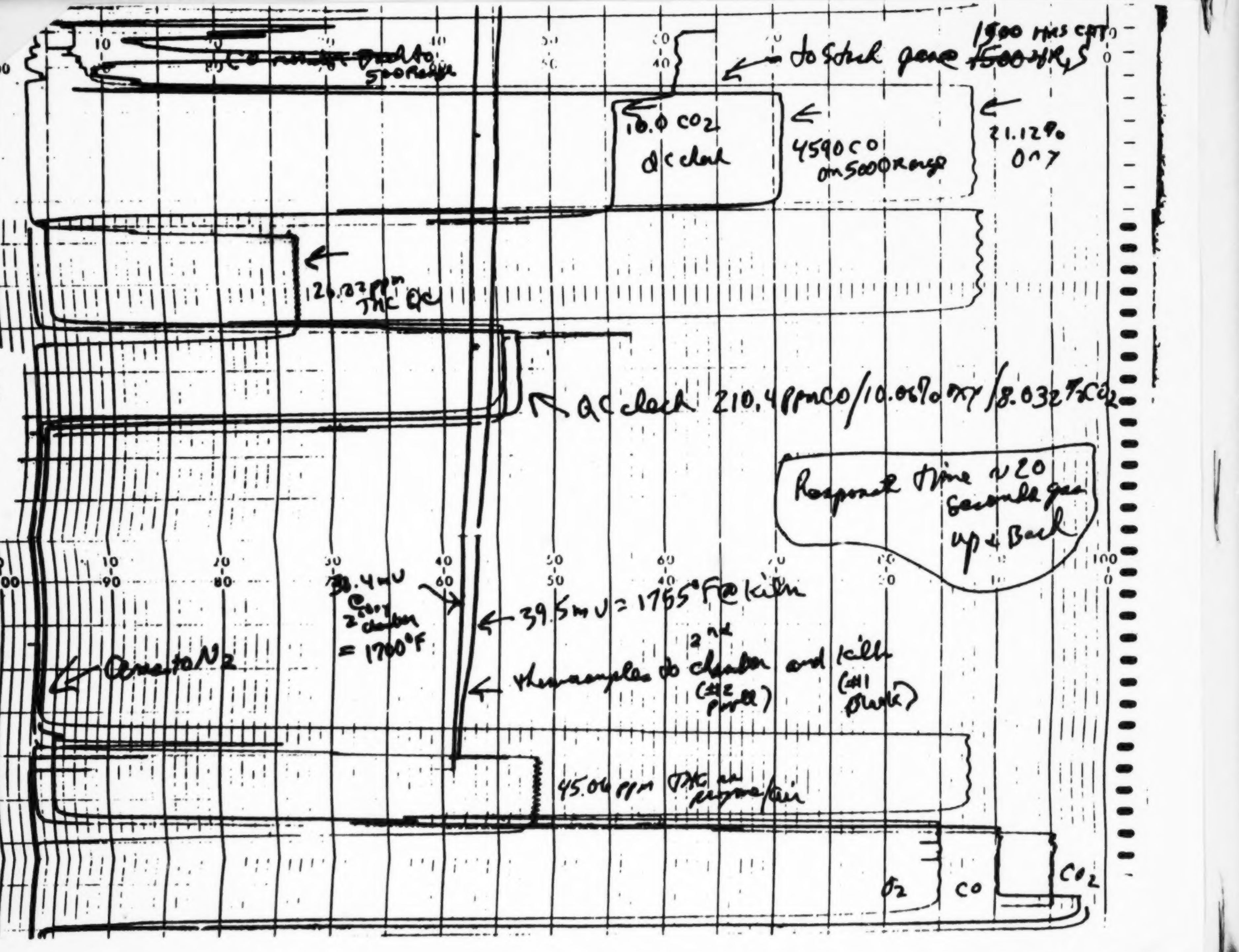
1700 Auto BC
Blow Back

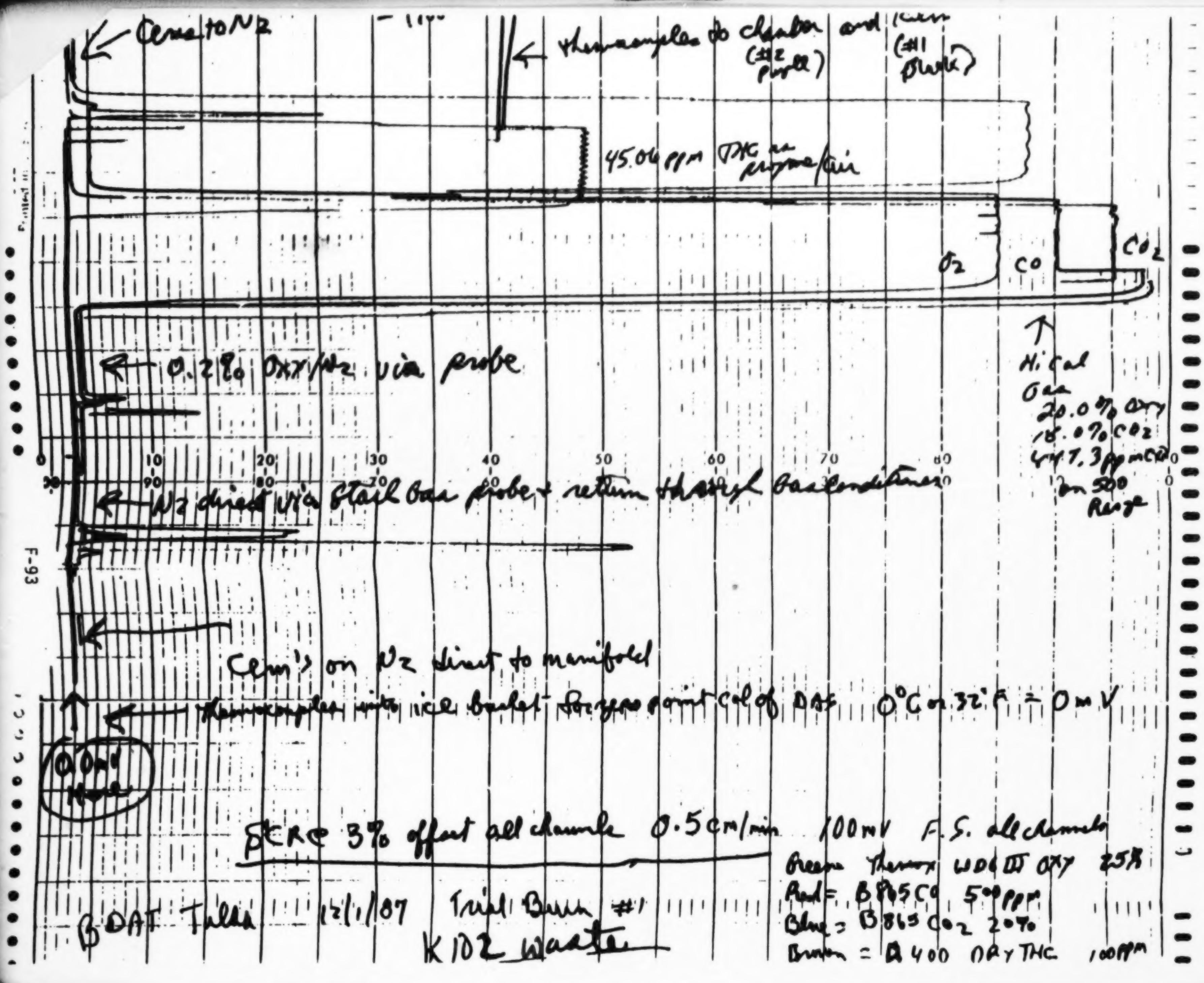

1700 Aut004
Blow Back
100 0
70 30
60 40
50 50
40 60
30 70
20 80
10 90
0 100
80
90
100
Printed in U.S.A.


100
0
10
90
20
80
30
70
40
60
50
~ 1616 HRS
(CO2)
T2
T1
Auto G.C. Blowback @ 1640 HRS
~ 1616 HRS
Oxy
CO
THC
Printed in

F-89


Auto E.C. Blowdown @ 1600 Hrs
C.O. to 500 Range
PMC Basis to 100 Range
PMC to 100 Range
C.O. to 500 Range
100
0
10
20
30
40
50
60
70
80
90

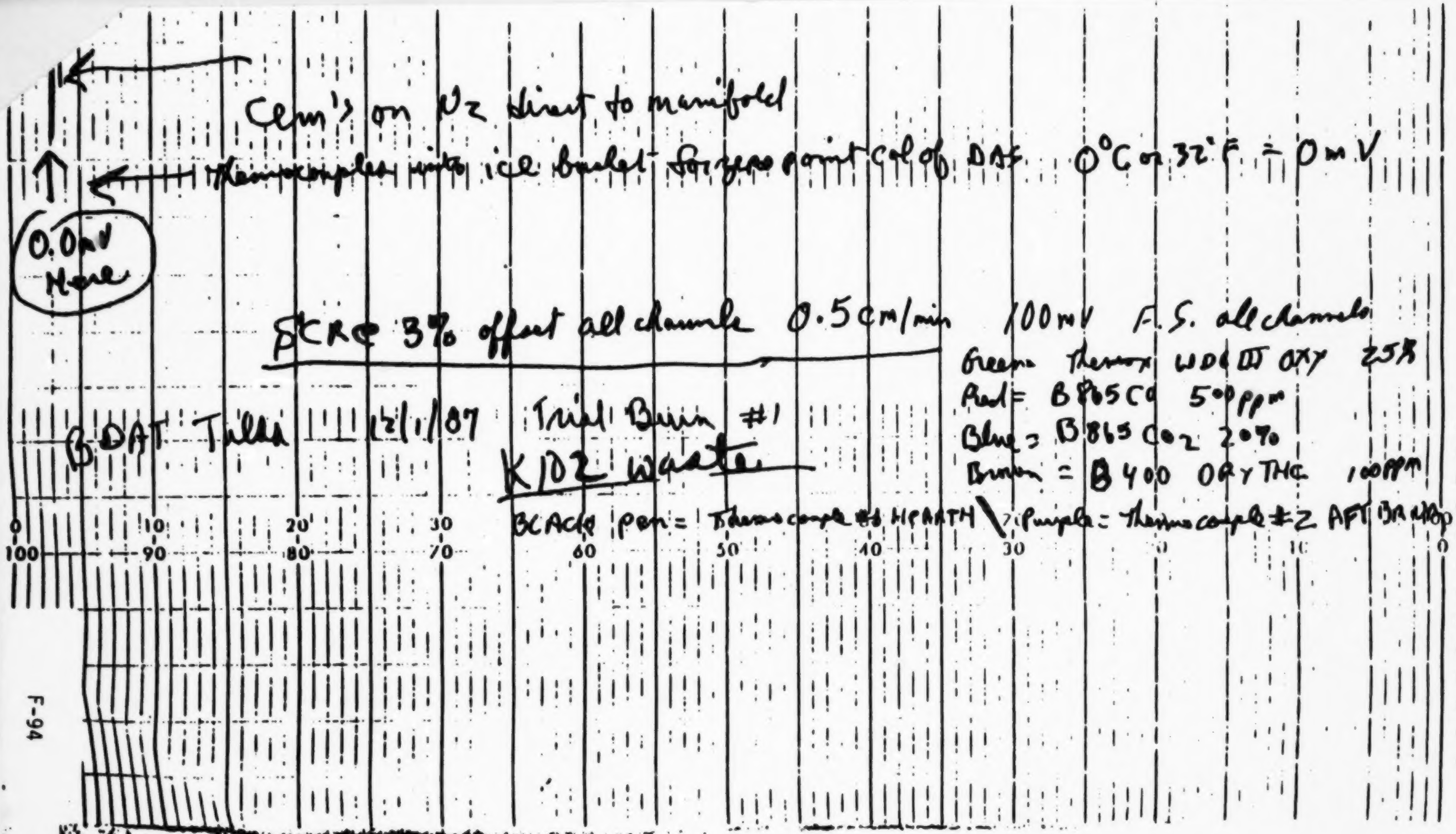

CO range back to 500 range
To Stack gas @ ~~1500 HRS~~ 1500 HRS CPT
10.0 CO2
QC check
4590 CO
on 5000 Range
21.12%
O2
126.32 ppm
THC QC
QC check 210.4 ppm CO/10.06% O2/8.032% CO2
Response time ~20 seconds gas up & Back
38.4 mV
@ 2nd chamber
= 1700°F
39.5 mV = 1755°F @ kiln
thermocouples to 2nd chamber (#2 purple) and kiln (#1 black)
Zero to N2
45.06 ppm THC in propane/air
O2
CO
CO2
0
10
20
30
40
50
60
70
80
90
100
Printed in U.S.A.



SCRC 3% offset all channels 0.5 cm/min 100 mV F.S. all channels

Green Thermox WDG III OXY 25%
Red = B 865 CO 500 ppm
Blue = B 865 CO2 20%
Brown = A 400 OXY THC 100 ppm

BDAT Tulsa 12/1/87 Trial Burn #1
K102 Waste



Cem's on O2 direct to manifold

Thermocouples into ice bucket for zero point cal of DAS. 0°C or 32°F = 0 mV

0.0 mV None

SCRC 3% offset all channels 0.5 cm/min 100 mV F.S. all channels

Green = Thermox WDG III OXY 25%
Red = B865 CO 500 ppm
Blue = B865 CO2 20%
Brown = B400 OR Y THC 100PPM

BDAT Tulsa 12/1/87 Trial Burn #1

K102 Waste

BLACK pen = Thermocouple #1 HEARTH \ Purple = Thermocouple #2 AFT BRNR